RELIABILITY IN COMPLEX INVENTORY ACCOUNTING SYSTEMS: A SENSITIVITY ANALYSIS

Frederic Henry Michael Kinley

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

RELIABILITY IN COMPLEX
INVENTORY ACCOUNTING SYSTEMS:
A SENSITIVITY ANALYSIS

by

Frederic Henry Michael Kinley
and
James O'Neill Carter

Thesis Advisor: D. C. Burns

September 1973

Approved for public release; distribution unlimited.

Reliability in Complex
Inventory Accounting Systems:
A Sensitivity Analysis

by

Frederic Henry Michael Kinley
Commander, United States Navy
B.S., United States Naval Academy, 1954
M.S., United States Naval Postgraduate School, 1962

and

James O'Neill Carter
Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1963
M.S., United States Naval Postgraduate School, 1972

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
September 1973

ABSTRACT

This thesis investigates the sensitivity of the reliability of the data generated by a complex inventory accounting system to changes in various internal and external factors effecting the subject accounting system. The subject system is represented by a computer simulation model of the inventory accounting subsystem of a hypothetical firm. The model, which is described in detail, was designed by David C. Burns; and was the subject of his doctoral dissertation. Sensitivity tests were performed on the computer model to investigate its responsiveness to various changes in both external and internal factors. The results of these sensitivity tests are analyzed with respect to their impact on the reliability of the data which makes up ending inventory account balances generated by the model. A dual quantitative method of measuring account balance reliability is also proposed and evaluated. A recommendation is made that the simulation technique be field tested for possible later status as a generally accepted auditing procedure.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

TABLE OF CONTENTS

I. INTRODUCTION -- 14

A. GENERAL -- 14

1. The Importance of Reliability to the Auditor's Internal Control Study and Evaluation ---------------------------------- 14

2. Reliability ------------------------------- 15

3. Auditing Complexity ------------------------ 15

4. Subjective Evaluation ---------------------- 17

B. PURPOSE -- 18

1. Sensitivity to Exogenous and Endogenous Factors -- 18

2. Prediction of Reliability ----------------- 19

3. Control Processes--Effective/Ineffective -- 19

4. Dual Measure of Reliability --------------- 19

C. METHOD --- 21

1. Computer Simulation Model ----------------- 21

2. Random Errors ----------------------------- 21

3. Sensitivity to Exogenous and Endogenous Factors -- 23

4. Prediction of Reliability ----------------- 23

5. Control Processes--Effective/Ineffective --- 24

6. Dual Measure of Reliability --------------- 24

II. SIMULATION MODEL DESCRIPTION ---------------------- 25

A. THE HYPOTHETICAL FIRM ------------------------- 25

1. Weakness of Accounting Controls ----------- 25

2. Accounting Errors ------------------------- 27

B. THE SIMULATION MODEL ---------------------- 28

1. Components ---------------------------- 28

a. Framework ------------------------- 28

b. Input Generators ------------------- 29

c. Erroneous Accounting Operations ----- 29

d. Parameters ------------------------ 29

2. Operating Characteristics -------------- 29

III. SENSITIVITY TESTS ---------------------------- 31

A. GENERAL ------------------------------------ 31

B. EXOGENOUS INPUT TESTS ---------------------- 31

C. ENDOGENOUS PARAMETER TESTS ---------------- 32

D. ACCOUNTING CONTROL TESTS ------------------- 33

E. ABSOLUTE ERROR COMPUTATIONS --------------- 34

IV. ANALYSIS OF SENSITIVITY TESTS ------------------ 36

A. GENERAL ------------------------------------ 36

B. EXOGENOUS INPUT TESTS ---------------------- 36

1. Changed Input Distribution ------------- 36

a. The Exponential Input Distribution -- 37

b. The Uniform Input Distribution ------ 37

2. Changed Input Distribution Means -------- 38

a. Changes in the Means of the Error Distributions ---------------------- 39

b. Changes in the Standard Deviations of the Error ----------------------- 39

C. ENDOGENOUS PARAMETER TESTS ----------------- 40

1. Changes in the Means of the Error Distributions -------------------------- 40

2. Changes in the Standard Deviations of the Error Distributions --------------------- 41

D. ACCOUNTING CONTROL TESTS -------------------- 41

1. Accounting Controls for Raw Materials --- 42

a. Unit Pricing ------------------------ 42

b. Unit Pricing and Unit Count --------- 45

2. Accounting Controls for Raw Materials, Work-In-Process and Finished Goods ------ 48

3. Weigh-Count for Finished Goods ---------- 52

E. INVESTIGATION OF ABSOLUTE ERRORS ------------ 53

1. Modification of the Model --------------- 53

2. The Base Case --------------------------- 54

3. Accounting Controls for Raw Materials, Work-In-Process and Finished Goods ------ 55

4. Changed Accounting Activity ------------- 58

V. CONCLUSIONS ------------------------------------- 59

A. GENERAL ---------------------------------- 59

B. PREDICTABILITY OF END RESULTS (ENDING INVENTORY ACCOUNT BALANCE ERROR) DUE TO CHANGES IN SYSTEM VARIABLES ----------------- 60

C. ENDOGENOUS INPUT TESTS --------------------- 61

1. Changed Input Distribution -------------- 61

2. Changed Input Distribution Means -------- 62

D. EXOGENOUS PARAMETER TESTS ------------------ 63

E. ACCOUNTING CONTROL TESTS -------------------- 63

F. ABSOLUTE ERROR ----------------------------- 65

APPENDIX A Detailed Description of the Computer Simulation Model ------------------------- 67

APPENDIX B Operational Flow Chart of the System Simulation Model ------------------------- 73

APPENDIX C Plots of the Probability Distribution of the Dollar Error in Raw Material, Work-In-Process, Finished Goods and Combined Ending Inventories ---------------------- 79

APPENDIX D Tabulations of the Changed Mean and Standard Deviation of the Distribution of the Dollar Error in Ending Inventories -- 175

COMPUTER PROGRAM -- 184

LIST OF REFERENCES ------------------------------------ 202

INITIAL DISTRIBUTION LIST ----------------------------- 203

FORM DD 1473 -- 204

LIST OF FIGURES

1. Standard Cost Buildup ---------------------------- 26

2. Locus of the Changed Mean of the Distribution of the Net Dollar Error in Ending Inventories Due to Accounting Controls (Unit Pricing) Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process ---------- 43

3. Locus of the Changed Mean of the Distribution of the Net Dollar Error in Ending Inventories Due to Accounting Controls (Unit Pricing and Unit Count) Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process - 47

4. Locus of the Changed Mean of the Distribution of the Net Dollar Error in Ending Inventories Due to Accounting Controls (Unit Pricing and Unit Count) Applied to Transactions in Raw Material, Work-In-Process and Finished Goods ----- 49

5. Locus of the Changed Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories Due to Accounting Controls Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process and to Transactions in Raw Material, Work-In-Process and Finished Goods --- 51

6. Locus of the Changed Mean of the Distribution of the Error and Absolute Error in Finished Goods and Combined Ending Inventories Due to Accounting Controls (Unit Pricing and Unit Count) Applied to Transactions in Raw Material, Work-In-Process and Finished Goods ------------------- 56

7. Locus of the Changed Dollar Standard Deviation of the Distribution of the Net Dollar Error and Absolute Dollar Error in Finished Goods and Combined Ending Inventories Due to Accounting Controls (Unit Pricing and Unit Count) Applied to Transactions in Raw Material, Work-In-Process and Finished Goods ------------------------------- 57

A-1. Cost of Goods Sold Statement for the Nine-Month Accounting Period -------------------------- 72

C-1. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories with Normal Distribution of Raw Material Shipment and Production Orders (Set of Four) ------------------ 79

C-2. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories with Exponential Distribution of Raw Material Shipments and Production Orders (Set of Four) -------- 83

C-3. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories with Uniform Distribution of Raw Material Shipments and Production Orders (Set of Four) ------------------ 87

C-4. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories When the Mean of the Normal Distribution of Raw Material Shipments and Production Orders Is Doubled (Set of Four) ---------------------------- 91

C-5. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Mean of the Exponential Distribution of Raw Material Shipments and Production Orders is Doubled (Set of Four) ------------------------------------ 95

C-6. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Mean of the Uniform Distribution of Raw Material Shipments and Production Orders is Doubled (Set of Four) -- 99

C-7. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Business Activity is Doubled (Set of Four) ----------------103

C-8. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Business Activity is Reduced by One-Half (Set of Four) ----107

C-9. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process Greater than \$3000 (Set of Four) ------------------------------111

C-10. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process. Greater than \$2000 (Set of Four) --115

C-11. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process Greater than $1000 (Set of Four) ---------------------------------- 119

C-12. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process Greater than $0 (Set of Four) -- 123

C-13. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process Greater than $3000 (Set of Four) ------------------------------ 127

C-14. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process Greater than $2000 (Set of Four) ------------------------------ 131

C-15. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process Greater than $1000 (Set of Four) ------------------------------ 135

C-16. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process Greater than $0 (Set of Four) --------------------------------- 139

C-17. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls Are Applied to Transactions in Raw Materials, Work-In-Progress and Finished Goods Greater than $3000 (Set of Four) ---------------- 143

C-18. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls Are Applied to Transactions in Raw Materials, Work-In-Process and Finished Goods Greater than $2000 (Set of Four) ---------------- 147

C-19. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls Are Applied to Transactions in Raw Materials, Work-In-Process and Finished Goods Greater than $1000 (Set of Four) ---------------------------------------151

C-20. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls Are Applied to Transactions in Raw Materials, Work-In-Process and Finished Goods Greater than $0 (Set of Four) ---------------------------------------155

C-21. Plot of the Probability Distribution of the Net Dollar Error in Ending Inventories when Weigh-Count Control on Transfer of Completed Products to Finished Goods is Tightened (Set of Four)---------------------------------------159

C-22. Plot of the Probability Distribution of the Absolute Dollar Error In Finished Goods and Combined Ending Inventories for the Base Case (Set of Two) ---------------------------------163

C-23. Plot of the Probability Distribution of the Absolute Dollar Error in Finished Goods and Combined Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material, Work-In-Process and Finished Goods Greater than $3000 (Set of Two) -------------------------165

C-24. Plot of the Probability Distribution of the Absolute Dollar Error in Finished Goods and Combined Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material, Work-In-Process and Finished Goods Greater than $2000 (Set of Two) -------------------------167

C-25. Plot of the Probability Distribution of the Absolute Dollar Error in Finished Goods and Combined Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material, Work-In-Process and Finished Goods Greater than $1000 (Set of Two) -------------------------169

C-26. Plot of the Probability Distribution of the Absolute Dollar Error in Finished Goods and Combined Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material, Work-In-Process and Finished Goods Greater than $0 (Set of Two) ----------------------------171

C-27. Plot of the Probability Distribution of the Absolute Dollar Error in Finished Goods and Combined Ending Inventories when Business Activity is Reduced by One-Half (Set of Two) --- 173

D-1. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories Due to Changes in the Distribution of Raw Material Shipments and Production Orders ------- 175

D-2. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories When the Mean of the Distribution of Raw Material Shipments and Production Orders Is Doubled ----- 176

D-3. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories when Accounting Activity Is Changed ----------------- 177

D-4. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process -------- 178

D-5. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Material Receipt and Transfer to Work-In-Process -- 179

D-6. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions in Raw Materials, Work-In-Process and Finished Goods -- 180

D-7. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error in Ending Inventories when Weigh-Count Control on Transfer of Completed Products to Finished Goods Is Tightened -------- 181

D-8. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error and Absolute Dollar Error in Finished Goods and Combined Ending Inventories when Accounting Controls (Unit Pricing and Unit Count) Are Applied to Transactions In Raw Materials, Work-In-Process and Finished Goods ------------------------------------182

D-9. Tabulation of the Changed Mean and Standard Deviation of the Distribution of the Net Dollar Error and Absolute Dollar Error in Finished Goods and Combined Ending Inventories when Accounting Activity Is Changed ------183

ACKNOWLEDGEMENTS

The assistance of Professor David C. Burns, Department of Operations Research and Administrative Sciences, United States Naval Postgraduate School, is gratefully acknowledged. Without his computer simulation model, upon which the sensitivity tests were performed, this study could not have been successfully completed. Professor Burns' model will be presented in a book of readings in accounting to be published by the American Accounting Association in late 1973.

I. INTRODUCTION

A. GENERAL

1. The Importance of Reliability to the Auditor's Internal Control Study and Evaluation

The auditor's study and evaluation of internal controls is an important step of the contemporary financial audit examinations conducted in both the public and private sectors. The study and evaluation of internal controls assists the auditor in two ways:

1) It helps him establish a basis for reliance upon internal controls in determining the nature, extent and timing of auditing tests to be applied in the examination of the financial records.

2) It provides the auditor a basis for making constructive suggestions to his clients concerning improvements in internal control.[1]

Reliability is an important aspect of the study and evaluation of internal controls. In performing an evaluation of internal controls, the auditor concentrates his efforts on those accounting controls which could have an important bearing on the reliability of the accounting records. Weak controls can have a bearing on the reliability of financial

---

[1] Committee on Auditing Procedure, Statement of Auditing Standards #1, American Institute of Certified Public Accountants, Inc., 1973, p. 14.

records because they can permit errors and irregularities to occur and remain undetected in the accounting records. Consequently, in the course of evaluating the adequacy of accounting controls, the auditor must often assess the impact various types of recurring errors and irregularities could have on the reliability of the records. These assessments provide the auditor a rational basis for deciding whether or not given weaknesses in accounting controls are material enough to affect his general reliance on internal control and hence require extended auditing procedures.

2. Reliability

In the context used above, "reliability" refers to "the expected freedom from error" of an accounting record and will be used synonymously with "accuracy," i.e., "the expected accuracy" of an accounting record. Consequently, for the remainder of this thesis, reliability will refer to the expected degree of freedom from error of an accounting record.

3. Auditing Complexity

The reliability of certain accounting records is extremely difficult to assess since it can be affected by interactions among a multitude of people, processes and procedures. For example, the ending stock inventory balance for a particular item at a Naval Supply Center could be affected by errors or irregularities committed by as many as twenty-five different people who might perform 100 different inventory-related processes and procedures. Hence, if accounting errors occurred at random at various points of such a complex process, the

resultant reliability of the account balance generated by the process would be a very complex random variable.

If an auditor decides to place reliance upon a specific group of internal controls, he must decide, in the course of his study and evaluation of internal controls, what error rates and error magnitudes he can tolerate from each person, process and procedure concerned with the controls in question. These tolerable error rates are then used to establish upper precision limits for tests aimed at determining the actual error rate. In deciding specific tolerance values, the auditor must assess the potential ramifications which various tolerable error rates and error magnitudes might have on the system in question. These assessments can become quite complex where an extensive system of controls is involved.

Some accounting and internal control sequences are so complex that it is extremely difficult to trace even one transaction through all of the system's processing and check points mentally (e.g., the Naval Supply Center). In these cases, it is consequently even more difficult to perform a confident mental assessment of how many errors of a given type might pass through all of the system's processing and check points unnoticed during an extended period of time. This complicates the task of evaluating the acceptability of alternative tolerable error rates and magnitudes. The difficulty is increased considerably when either offsetting or compounding errors are possible. Where subsystems of controls are involved, the assessment problem can become hopelessly complex. This is

especially true when the potential impact of several different types of errors must be jointly assessed.

4. Subjective Evaluation

Audit circumstances sometimes require that the auditor assess the adequacy of an entire subsystem of controls which relates to some specific account balance (e.g., all controls related to the stock accounts of a Naval Supply Center). When tolerable exception rates must be established for this type of subsystem, the evaluation is normally made in two basic steps:

1) Each component operation of a particular accounting subsystem is assessed separately with respect to tolerable error rates and magnitudes. This step enables the auditor to ascertain the effect of these tolerable error rates and magnitudes on the reliability of each component accounting operation which composes the accounting subsystem in question.

2) The joint effect of all of the tolerable error rates established in Step 1 on the overall reliability of the account balance is then subjectively inferred from the results of the assessments of each of the component operations of the accounting subsystem. This step constitutes a subjective joint assessment of the impact of all the tolerable error rates established.

Auditors do not use any type of mathematical method to assist them in these assessments. Where the accounting system is complex, present methods do not allow auditors to make subjective assessments with a high degree of confidence. In

at least one experimental case involving a manufacturing inventory subsystem, it was shown that an auditor, under conditions of perfect knowledge including perfect knowledge of the actual error rate which occurred at six points of the system, could not make an accurate subjective assessment of the reliability of the account balances generated by the system.[2]

B. PURPOSE

In general, the major purpose of this thesis is to perform various sensitivity analyses on an inventory accounting system model in order to: (a) determine the extent to which predictions might be made about the reliability of the account balance, given a change in a system variable such as volume of activity; (b) determine the effectiveness or ineffectiveness of changes in accounting controls such as the addition of certain internal accounting checks; and (c) examine a dual measure of system reliability.

1. Sensitivity to Exogenous and Endogenous Factors

The sensitivity of the reliability of the ending inventory account balances to changes in exogenous (external

---

[2]David C. Burns, Audit Evidence Evaluation Using Computer Simulation with Special Emphasis on Ascertaining the Reliability of Accounting Data (Indiana State University Graduate School of Business, 1971), unpublished Doctoral Dissertation. A CPA audited the outputs of this model. Given perfect information, this CPA was unable to assess the potential accuracy of the combined inventory balance generated by the system. Validation procedures and the question of cost effectiveness are addressed in the dissertation. Professor Burns' model will be presented in a book of Readings in Accounting to be published by the American Accounting Association in late 1973.

to the system) and endogenous (internal to the system) factors is investigated. For example, the size and nature of input transactions (i.e., quantities of raw materials and numbers of transactions) are varied. Additionally, certain accounting controls are introduced which cause transactions above a certain dollar threshold to be corrected.

2. Prediction of Reliability

The extent to which account balance reliability could be predicted at the time of the change in exogenous or endogenous variables is examined. For example, it was determined whether doubling the volume of input transactions implied that the total error resulting in the balance would also double or whether it would change in some set proportion.

3. Control Processes -- Effective/Ineffective

The addition of certain internal accounting checks is investigated to determine whether they might lead to counter-intuitive and sometimes dysfunctional results. For example, it would be intuitive to expect the assignment of an additional person to double check the pricing of all high value (over a certain dollar threshold) orders to be cost effective by increasing the reliability of the records involved.

4. Dual Measure of Reliability

The usefulness of a dual measure of reliability is tested. The traditional measure, the algebraic sum or net error, includes a certain amount of cancellation where both positive and negative errors are involved (i.e., transaction overstatements and understatements, respectively). A criticism

of sole reliance upon the net error measure of reliability would be that it does not discriminate between: (a) the situation where all errors, however large, are exactly compensated for by similar errors of an opposite sign, and consequently yield a net error of zero; and (b) the situation where no error exists. These two cases are significantly different.

To compensate for this net error problem, an additional measure of reliability was introduced. The additional method proposed was the cumulative amount of the absolute dollar value of each error committed by the process in question. In the researchers' opinion, this absolute error measure gives a true measure of the magnitude of the corrective effort required to reconcile any existing errors (i.e., both positive and negative). The net error, on the other hand, gives a better measure of the impact of this corrective effort on the expected accuracy of the financial records. The chief drawback to sole reliance upon the absolute error measure however, is that it makes no distinction between a situation in which all errors net and one in which there is no netting. It is the researchers' opinion that useful information is gained by using both measures of reliability simultaneously, since use of both provides information which remedies the criticisms of each. This will be illustrated in Chapter IV.

C. METHOD

1. Computer Simulation Model

A computer simulation model of the inventory accounting system of a hypothetical manufacturing firm was used to accomplish the threefold purpose of this study. The model allowed the researchers to study and observe the ramifications of various changes in the system under controlled conditions. Controlled conditions made it possible to record quantitatively the actual reliability of the accounting records generated by the inventory accounting system and hence provided an objective basis for judging the degree of responsiveness of the system to controlled changes.

The model maintained two separate but parallel sets of standard cost inventory accounting records, a Reported set which was subject to random accounting errors and a Control set which was subject to no error. The model was designed to generate input data from probability distributions specified by the researchers. Internal control processes, such as dollar thresholds above which all transactions were checked for accuracy (and corrected if necessary), could be adjusted by the user. Also, the volume of accounting activity simulated by the model could be varied.

2. Random Errors

The program was designated to commit various types of processing errors (as is discussed in Chapter II), and to generate internally its own source documents and other accounting input data. Vendors' invoices, production orders and other

types of traditional input data were generated internally in accordance with parameters specified by the researchers and then were processed by the same computer program. The input data which were fed to the program externally were: (a) data which specified the gross volume of accounting activity to be processed during one simulation run (i.e., the accounting period); (b) beginning inventory levels; (c) standard cost data; (d) error frequency rates; and (e) the specific amount or magnitude of each of the types of processing errors.

Certain unreliable processing characteristics of the hypothetical accounting system were incorporated into the design of the computer program. These unreliable characteristics caused the computer program to commit errors of a controlled magnitude with a specified constant frequency throughout the simulation time period which was assumed to be nine months. The computer program was designed to use the Monte Carlo Method to determine when to cause a specific occurrence of each of the different types of processing errors referred to above. (The Monte Carlo Method is a technique for generating stochastic deviates from a specified probability distribution using the computer's pseudo-random number generator.) Correct and erroneous standard costs and error frequency rates were fed to the program as external inputs. Thus, the model was designed to hold constant the system's potential for committing processing errors throughout the accounting period and to permit chance to determine which transactions were to be processed erroneously. Pseudo-random numbers were used to

trigger the occurrence and nature of processing errors at every location within the model where an error process was simulated. The model was designed to maintain complete control over every error committed by the system and also to keep a record of the errors which were occurring. Monte Carlo processes introduced random errors into the Reported inventory account balances throughout the simulation time period (i.e., both errors of understatement and errors of overstatement).

3. <u>Sensitivity to Exogenous and Endogenous Factors</u>

The model was designed to generate individual input transactions from specified probability distributions up to some limit which was assumed to represent nine months in the case of most runs. Input data was generated from three different types of probability distributions: normal, exponential, and uniform. Also, the effectiveness of internal controls was varied by changing the dollar transaction thresholds above which transactions were checked for accuracy. This is discussed in detail in Point 4 below.

4. <u>Prediction of Reliability</u>

The simulation of different levels of activity for different input distributions yielded information about the predictability of end results when making changes to input variables and internal checking processes. N-th order results (end results) were predicted accurately when a first-order (input variable) or second-order (internal check process) variable was changed in some cases and were not predicted accurately in others.

5. Control Processes -- Effective/Ineffective

A control process was implemented and sensitivity tested within the simulation model. This process represented the activity of a person who double checks the accuracy of the price in all raw material transactions with an extended dollar value exceeding a certain dollar threshold.

6. Dual Measure of Reliability

Provisions were made in the computer simulation model to accumulate the total dollar value (absolute value) of each individual error committed by the system in processing the exogenous input data. The model was already designed to isolate the net error which resulted in the ending inventory balance after processing all of the exogenous input data.

II. SIMULATION MODEL DESCRIPTION

A. THE HYPOTHETICAL FIRM

The basis for the computer simulation model was the manual processing activity of the inventory accounting system of a hypothetical manufacturing firm. The processes of the hypothetical firm and its inventory accounting system were abstracted from those which occurred in an actual business firm.

The actual firm was engaged in the machining and sales of a complete line of alloy and cast-iron pipe fittings. To minimize complexity, the hypothetical firm and the simulation model were limited to the accounting activity related to only four products from this total line which will be referred to by number, products 1, 2, 3 and 4. Production related to these four products took place in the firm's two manufacturing departments -- Departments I and II.

The financial inventory records of the hypothetical firm carried raw materials, work-in-process and finished goods inventories at predetermined standard costs. Accounting operations were carried out manually. A standard cost build-up for Products 1, 2, 3 and 4 is given in Fig. 1.

1. Weaknesses In Accounting Controls

The hypothetical firm was plagued by several weaknesses in internal accounting controls related to inventories. These weaknesses were:

[illegible]

[illegible]

[illegible]

FIGURE 1

STANDARD COST BUILD-UP

	Product Number 1	Product Number 2	Product Number 3	Product Number 4
Direct Material				
Type of Material	R. M. 1	R. M. 2	R. M. 3	R. M. 4
Units Required	1	1	1	1
Spoilage/Scrap, etc.	0	0	0	0
Standard Cost of Material	$13.5000	$16.7000	$ 6.5000	$ 8.000
Total/Unit	$13.5000	$16.7000	$ 6.5000	$ 8.000
Direct Labor				
Department I				
Std. dir. lbr. hrs./unit	.06 hr.	.09 hr.	.04 hr.	.06 hr.
Std. dir. lbr. rate	$6.20/hr.	$6.20/hr.	$6.20/hr.	$6.20/hr.
Total std. dir. lbr. charge	$ .3720	$ .5580	$ .2480	$ .3720
Department II				
Std. dir. lbr. hrs./unit	.04 hr.	.06 hr.	.04 hr.	.07 hr.
Std. dir. lbr. rate	$5.60/hr.	$5.60/hr.	$5.60/hr.	$5.60/hr.
Total std. dir. lbr. charge	$ .2240	$ .3360	$ .2240	$ .3920
Total/Unit	$ .5960	$ .8940	$ .4720	$ .7640
Burden				
Department I				
Std. dir. lbr. hrs./unit	.06 hr.	.09 hr.	.04 hr.	.06 hr.
Std. burden rate	$12.85/hr.	$12.85/hr.	$11.40/hr.	$11.40/hr.
Total std. burden charge	$ .7710	$ 1.1565	$ .4560	$ .6840
Department II				
Std. dir. lbr. hrs./unit	.04 hr.	.06 hr.	.04 hr.	.07 hr.
Std. burden rate	$51.55/hr.	$51.55/hr.	$44.05/hr.	$44.05/hr.
Total std. burden charge	$ 2.0620	$ 3.0930	$ 1.7620	$ 3.0835
Total Burden/Unit	$ 2.8330	$ 4.2495	$ 2.2180	$ 3.7675
Total Unit Standard Cost	$16.9290	$21.8435	$ 9.1900	$12.5315

Abbreviations: std.=standard; dir.=direct; lbr.=labor; hrs.=hours.

[illegible]

1) Receiving and inspection personnel were lax and did not physically count all incoming shipments of raw materials.

2) Standard cost files were not maintained in an orderly fashion.

3) Foremen did not check the accuracy of each of their machine operators' production counts.

4) Prudent safeguards were not employed to control access to the raw materials storage area.

5) Completed production orders were weigh-counted before they were transferred into the finished goods storage area. However, the weigh-count operator was lax in carrying out his duties.

2. Accounting Errors

The weaknesses in internal controls in the various inventory accounting processes permitted the following five types of errors to occur:

1) Vendors' shipments of raw materials sometimes contained more units than were recorded on the vendor's invoice and shipper invoices. The laxity of receiving and inspection personnel sometimes caused these understatements to remain undetected.

2) The carelessly-maintained standard cost files caused inappropriate standard costs to be applied in vouchering of raw material purchases, costing-out production reports, and costing-out completed production orders transferred to finished goods.

3) The inattention of foremen caused random overstatements of production counts in both Departments I and II to remain undetected.

4) The lack of prudent safeguards for control of access to the raw materials storage area resulted in unobserved and unrecorded return of the excess raw materials which had been requisitioned to cover the inflated production orders.

5) The duties of the weigh-count operator were to correct inflated production counts. His laxity permitted these erroneous production counts to remain undetected and uncorrected.

These unreliable accounting operations, which resulted in both overstatements and understatements, were included in the design of the simulation model and are described in Appendix A.

B. THE SIMULATION MODEL

1. Components

The components of the computer simulation model are as follows:

a. Framework

The framework of the model is an abstract inventory accounting computer program. The functions of the framework include maintaining inventory account balances, vouchering raw material purchases, and costing-out material requisitions, production reports, transfers of finished goods, and sales. The framework is designed to maintain two separate but parallel sets of inventory accounting records -- A Reported set and a

Control set. The Reported records are affected by simulated errors, the Control set is not.

b. Input Generators

The model includes several external input generators which create the input data to be processed by the framework. These data include raw material shipments, production orders and raw material requisitions.

c. Erroneous Accounting Operations

The model includes several Monte Carlo computer routines that simulate the erroneous accounting operations and hence cause processing errors to occur at random in accordance with predefined probability distributions. These errors affect only the reliability of the Reported records. Simulated errors do not affect the Control records.

d. Parameters

The parameters of the model include files of erroneous and correct standard cost information, levels of beginning inventory, and quantities which limit the total volume of financial accounting activity to be processed during the nine-month period.

2. <u>Operating Characteristics</u>

Included in the model is a set of computer statements which causes the model to replicate 1500 times the previously described simulation process (i.e., nine months of activity in the "base case" described in Chapter III). Fifteen hundred replications were required to obtain stable sample statistics for purposes of academic validation. However, the statistics

available after two hundred replications were suitable for practical purposes. The model uses pseudo-random numbers to trigger the error generation of the simulation. For each of the 1500 replications of the model, a different sequence of pseudo-random numbers is selected by the program. Consequently, during each of the 1500 replications, a different combination of processing errors occurs on different combinations of transactions. This causes the total resultant error in the various ending inventory balances to be different at the conclusion of each replication.

The model is designed to isolate the total error in the ending inventory balances at the conclusion of each of the 1500 replications. The model is also designed to plot these errors as a probability distribution and to compute the mean and standard deviation of the distribution.

It is precisely this probability distribution with its mean and standard deviation which, for the purposes of this paper, is the measure of reliability of an ending inventory account balance.

A detailed description of each component is given in Appendix A. A complex explanation of the operational aspects of the model is provided by the Operational Flow Chart in Appendix B.

III. SENSITIVITY TESTS

A. GENERAL

For purposes of this research, the "base case" was established as:

1) An accounting activity level of nine months.

2) Raw material shipments and production orders generated from a normal distribution.

3) Random occurrences of errors as discussed in Chapter I and Appendix A.

A series of tests were conducted to determine the degree of sensitivity of the reliability of the ending inventory balances generated by the model. This degree of sensitivity was measured from the base case with respect to changes in exogenous inputs and endogenous parameters, and with respect to establishment of certain accounting controls.

After each change was made, the model was replicated 1500 times. The total dollar amount of the net resultant error in the various ending inventory balances was isolated for each replication. A probability distribution of these net errors covering 1500 replications of the model was plotted for each inventory balance. A mean and standard deviation was computed for each distribution.

B. EXOGENOUS INPUT TESTS

In the base case, the exogenous inputs of raw material shipments and production orders were generated from a normal

distribution with the following means and standard deviations:

		Mean	Standard Deviation
Raw Material Shipments			
Raw Material:	1 & 3	200	25
	2 & 4	180	30
Production Order Sizes			
Product:	1 - 4	150	35

The changes which were made with respect to these inputs were:

1) The raw material shipments and production orders were generated from: (a) normal distributions; (b) exponential distributions; and (c) uniform distributions. This was done while keeping the distribution means constant.

2) The mean of each distribution was doubled and the raw material shipments and production orders were generated from the same distributions as in subparagraph B.1) above.

C. ENDOGENOUS PARAMETER TESTS

In the base case, the volume of accounting activity processed by the simulation model for the nine-month period was established by the following set of parameters:

Raw Material Purchases	\$1,584,800
Raw Materials Used	1,450,400
Direct Labor	87,183
Factory Overhead	417,497
Cost of Goods Manufactured	1,734,795
Cost of Goods Sold	1,731,114

The changes which were made with respect to these parameters consisted of: (a) doubling the above set; and (b) reducing the set by one-half.

D. ACCOUNTING CONTROL TESTS

As previously described, the simulation model caused random processing errors of various types, magnitudes, and combinations to occur at random times during each nine-month replication. In order to investigate the corrective effects of various accounting controls on the reliability of the inventory balances, the model was altered to:

1) Correct all pricing errors which occurred on transactions dealing with raw material receipt and transfer to work-in-process if (the extended dollar amount of) the transaction exceeded a certain accounting control dollar threshold. These thresholds were $3,000, $2,000, $1,000 and $0. For each threshold, an activity level of nine months was simulated and the error in the ending inventory account balances recorded for 1500 replications. This accounting control process was designed to simulate the activity of an employee whose duty was to correct (or partially compensate for) the errors caused by the weakness of the improperly-maintained standard cost files for raw material.

2) Correct all pricing and unit counting errors which occurred on transactions dealing with raw material receipt and transfer to work-in-process if the extended dollar amount of the transaction exceeded the same accounting control dollar thresholds of $3,000, $2,000, $1,000 and $0. This accounting control process was designed to simulate the activities of several employees whose duties were to correct (or partially compensate for) not only the errors caused by the weakness of improperly-maintained raw material standard cost files, but

also the errors caused by the weaknesses associated with laxity of receiving and inspection personnel and production foremen.

3) Correct all pricing and unit counting errors which occurred on any transaction dealing with raw material, work-in-process or finished goods if the transaction exceeded the same thresholds stated previously. This progression of accounting control processes would simulate the activities of several employees whose duties were to correct not only the errors caused by the weaknesses of improperly-maintained raw material standard cost files and laxity of receiving and inspection personnel and production foremen, but also the errors caused by the weakness of improperly-maintained standard cost files for costing-out production orders.

4) Tighten the parameter which controlled the effectiveness of the weigh-counting of completed production orders transferred to finished goods. In the base case, the weigh-count operator corrected the production order quantity only if the difference between the weigh-count and the amount stated on the production order exceeded 20 units. This difference was tightened to 10 units.

E. ABSOLUTE ERROR COMPUTATIONS

For any particular nine-month period (i.e., computer iteration), the complex random variable which represented the resultant net dollar error in ending inventory balance was composed of the net amount of all of the random errors which

occurred in processing all of the exogenous inputs to the model. These individual transaction errors included both errors of overstatements and errors of understatements when compared to their Control counterparts.

The simulation model was modified to compute not only the resultant net dollar error in ending inventories but also to accumulate the absolute dollar amount of each error generated by the model during the simulation run. These absolute dollar errors were accumulated in terms of the finished goods and combined ending inventories of the base case.

Comparisons were made of the changes in the mean and standard deviation of the distributions of the absolute dollar error of these ending enventories when:

1) Pricing and unit count transactions related to raw material, work-in-process and finished goods were corrected if the extended dollar value of the transaction exceeded the accounting control dollar thresholds of $3,000, $2,000, $1,000 and $0. This was parallel to the situation of sub-paragraph D.3) above.

2) Accounting activity was reduced by one-half. The accounting activity was not doubled due to the time constraints for completion of this thesis.

IV. ANALYSIS OF SENSITIVITY TESTS

A. GENERAL

The output of the simulation model consisted of:

1) Plots of the probability distributions of the resultant net dollar error accumulated in the following ending inventories: raw materials, work-in-process, finished goods, and combined. The plots are displayed in the sets of figures in Appendix C.

2) Plots of the probability distributions of the absolute dollar error accumulated in the finished goods ending inventory balance and in the combined ending inventory balance. These plots are displayed in the sets of figures in Appendix C.

3) The mean and standard deviation of each of the above probability distributions. These sample statistics are tabulated and displayed in Appendix D.

Additionally, for ease of reference and comparison, the locus of the changed mean or standard deviation of certain of the above probability distributions are graphed along with the mean or standard deviation of the base case.

B. EXOGENOUS INPUT TESTS

1. Changed Input Distribution

The sensitivity of the model was tested for three distributions from which the raw material shipments and production orders were generated: (a) a normal distribution (the base case); (b) an exponential distribution; and (c) a uniform distribution.

Figure C-1 is the base case set of distribution plots of the resultant net dollar error accumulated in the ending inventories. Figure C-1a is the distribution plot for raw material. Figure C-1b is the distribution plot for work-in-process. Figure C-1c is the distribution plot for finished goods. Figure C-1d is the distribution plot for combined. The same lettering sequence technique is applied to subsequent sets of distribution plots.

Figures C-2 and C-3, respectively, are the sets of distribution plots of the resultant net dollar error in the ending inventories when the raw material shipments and production orders were generated from exponential and uniform distributions.

Figure D-1 is a tabulation of the mean and standard deviation of each of these distributions.

a. The Exponential Input Distribution

The means of the distributions of the net resultant error in the ending inventory of raw materials and work-in-process were not substantially changed from those which resulted in the base case. In the case of the finished goods error distribution, the mean error was reduced from \$20,688 to \$7,088. This change seems to have been due to the large number of small production orders of ten or less units which were generated from the exponential distribution of production orders (i.e., in the case of the exponential distribution, nearly one-half of the production orders were for ten or less units; in the base case there were no orders for ten

or less units). When costing out the completed production orders, the large numbers of small orders led to fewer transaction overstatements and apparently contributed to the reduced amount of resultant net error in the finished goods ending inventory balance.

The changes in the standard deviation of the net error distributions from those resulting in the base case were substantial in all four ending inventory distributions. These changes in standard deviations are again explained by the large number of small raw material shipments and production orders.

b. The Uniform Input Distribution

Both the means and standard deviations of the distributions of the net resultant error in the ending inventories showed insignificant change from those resulting in the base case. The error processes have a similar effect on the normally- and uniformly-distributed exogenous inputs as long as the means of the input distributions remain unchanged. This similarity illustrates the stability of the simulation model with respect to normally- and uniformly-distributed input data.

2. <u>Changed Input Distribution Means</u>

The mean of each of the three input distributions was doubled. This change had the effect of doubling the size of individual raw material shipments and production orders generated.

Figures C-4 through C-6, respectively, are the sets of distribution plots of the resultant net dollar errors in the ending inventories. Figure D-2 is a tabulation of the mean and standard deviation of each of these distributions.

a. Changes in the Means of the Error Distributions

An inspection of Fig. D-2 shows that the means of the distributions of the net dollar error in the raw materials and work-in-process ending inventories remained essentially unchanged. However, in finished goods ending inventory, a substantial change did occur for all three input distributions.

This change in finished goods is explained by the fact that the doubled size of the production orders causes the overstatements of completed orders to exceed the weigh-count control difference threshold of 20 units more frequently than in the base case. In the base case, the mean of the net dollar error in the finished goods distribution had been a large overstatement and the error from single replications had ranged from $7,000 to $22,600. When the mean of the production orders was doubled, the bulk of the overstatements due to inflated production orders were discovered by the weigh-count control process and corrected.

b. Changes in the Standard Deviations of the Error Distributions

Additional inspection of Fig. D-2 reveals that, as the mean of the input distribution was doubled, the standard deviation of the resultant net error distribution increased by a factor of the square root of two. This was not a

surprising result because the standard deviation is mathematically defined as the square root of variance. That is, by doubling the mean of the distribution from which the raw material and production orders were generated, it was reasonable for the variance of the error distribution to double and consequently the standard deviation to increase by a factor of the square root of two. Hence, in this respect, the behavior of the model was predictable.

C. ENDOGENOUS PARAMETER TESTS

The sensitivity of the model was tested with respect to changes in accounting activity. The accounting activity level was changed from the base case of nine months to: (a) eighteen months; and (b) four and one-half months. This had the effect of doubling and reducing by one-half the base case accounting activity level.

Figures C-7 and C-8, respectively, are the sets of distribution plots of the resultant net dollar errors in the ending inventories when the accounting activity is doubled and reduced by one-half. Figure D-3 is a tabulation of the mean and standard deviation of each of these distributions.

1. Changes in the Means of the Error Distributions

There was a direct proportional relationship between accounting activity level and mean error. When the activity level was doubled, the mean of the error distribution was doubled. When the accounting activity level was reduced by one-half, the mean of the error distribution was reduced by one-half. This was to be expected because there was no way

for error to leave the inventory accounting system of the simulation model unless it was netted out.

2. Changes in the Standard Deviation of the Error Distributions

As was expected, the standard deviation of the error distribution did increase or decrease substantially as the volume was doubled or reduced by one-half. In fact, the change in the standard deviation again was a function of the square root of two. Again, this was not a surprising result and is explained in subparagraph B.2.b. above.

D. ACCOUNTING CONTROL TESTS

The hypothetical firm was beset by several types of accounting weaknesses. For example, raw materials when received were not always inspected and counted, standard cost files were improperly maintained, and production foremen were lax. The simulation model was modified to include various accounting controls which were designed to correct certain transactions for specific types of processing errors if the extended dollar value of the transaction exceeded a certain specified threshold. These thresholds were $3,000, $2,000, $1,000 and $0. These modifications were assumed to simulate the activities of employees whose duties were to correct, or partially compensate for, the various accounting weaknesses inherent in the system. The analysis of the results of the sensitivity tests conducted with respect to changes in the accounting controls follows.

1. Accounting Controls for Raw Materials

The predominant cost to manufacture goods in the case of the hypothetical firm is direct material cost -- direct raw material costs are greater than the combined cost of direct labor and factory burden by a ratio of almost three to one. Therefore, accounting controls were established for unit pricing and unit count of direct raw materials transactions.

a. Unit Pricing

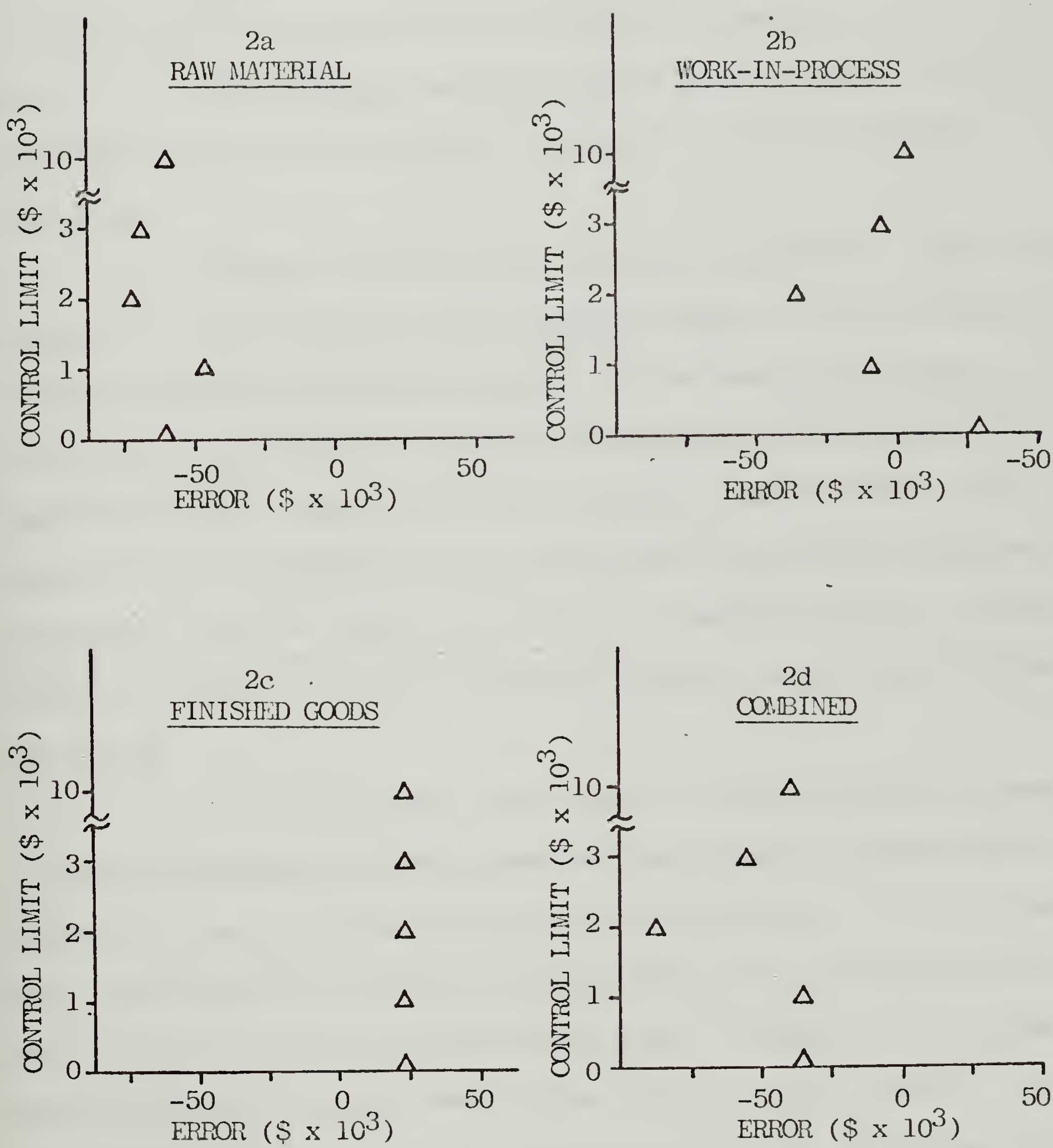
The simulation model was modified to include accounting controls designed to check the accuracy of transaction pricing calculations. This modification ensured that all raw material transactions of an extended dollar amount greater than the dollar threshold (control limit) were corrected.

Figures C-9 through C-12, respectively, are the sets of distribution plots of the resultant net dollar errors in the ending inventories when the accounting control threshold is \$3,000, \$2,000, \$1,000, and \$0. Figure D-4 is a tabulation of the mean and standard deviation of each of these distributions.

The significant results of this test are displayed in Fig. 2 which contains four graphs. Graph 2a shows the locus of the changing mean of the distribution of the resultant net dollar error in the raw material ending inventory balance as the accounting control threshold is varied. Graph 2b shows the locus of the changing distribution mean for the

FIGURE 2

LOCUS OF THE CHANGED MEAN OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES DUE TO ACCOUNTING CONTROLS (UNIT PRICING) APPLIED TO TRANSACTIONS IN RAW MATERIAL RECEIPT AND TRANSFER TO WORK-IN-PROCESS.



work-in-process ending inventory balance. Graph 2c shows the locus of the changing distribution mean for the finished goods ending inventory balance. Graph 2d shows the locus of the changing distribution mean for the combined ending inventory balance. This lettering sequence technique applies to Figures 3 through 6.

The ordinate of each graph is the accounting control threshold in dollars with the base case·denoted at tic-mark "10". The abscissa of each graph is the mean of the distribution of the resultant net dollar error in ending inventory.

Figure 2a depicts a counter-intuitive result which occurred in the locus of the changing mean of the distribution of the resultant net dollar error in raw material ending inventory. Instead of steadily decreasing as the controls were tightened (i.e., the thresholds changed from $3,000 to $0), the mean of the distribution for the $3,000 and $2,000 thresholds increased from that which occurred in the base case. The net resultant error in the raw material ending inventory balance increased.

To investigate the cause of this apparent anomaly, a detailed examination was made of individual transactions related to receipt and transfer of raw material. This examination revealed that transaction overstatements related to raw material #4 were the transactions most frequently corrected when the $3,000 and $2,000 control limits were applied. The correct standard cost for raw material #4 was $8.00 per unit;

the erroneous standard cost was $16.70 per unit. Transactions using the erroneous standard cost were overstatements which frequently exceeded the $3,000 and $2,000 thresholds. The result was to correct more overstatements than understatements thus increasing the net resultant error in the ending inventory of raw materials and increasing the mean of the distribution. When the $1,000 control limit was applied, the mean error commenced to decrease.

An examination of the standard deviations in Fig. D-4 reveals intuitive results. Except for the finished goods inventory, there is a monotonic decrease in the standard deviations of the distributions of resultant net error in ending inventories as the transaction threshold decreases. That is, each of the distributions gets tighter as more transactions are corrected (i.e., the range of errors decreases). Figure D-4 also shows that the transactions in finished goods were totally decoupled from the transactions related to raw materials because completed production orders were repriced before transfer to finished goods. Therefore, it was intuitive to expect the mean and the standard deviation of the distribution of the resultant net dollar in the finished goods ending inventory balance to remain unchanged from the base case as tighter accounting controls were introduced.

b. Unit Pricing and Unit Count

As the next step, additional accounting controls were introduced in the simulation model. These additional controls caused the quantities of raw materials received and

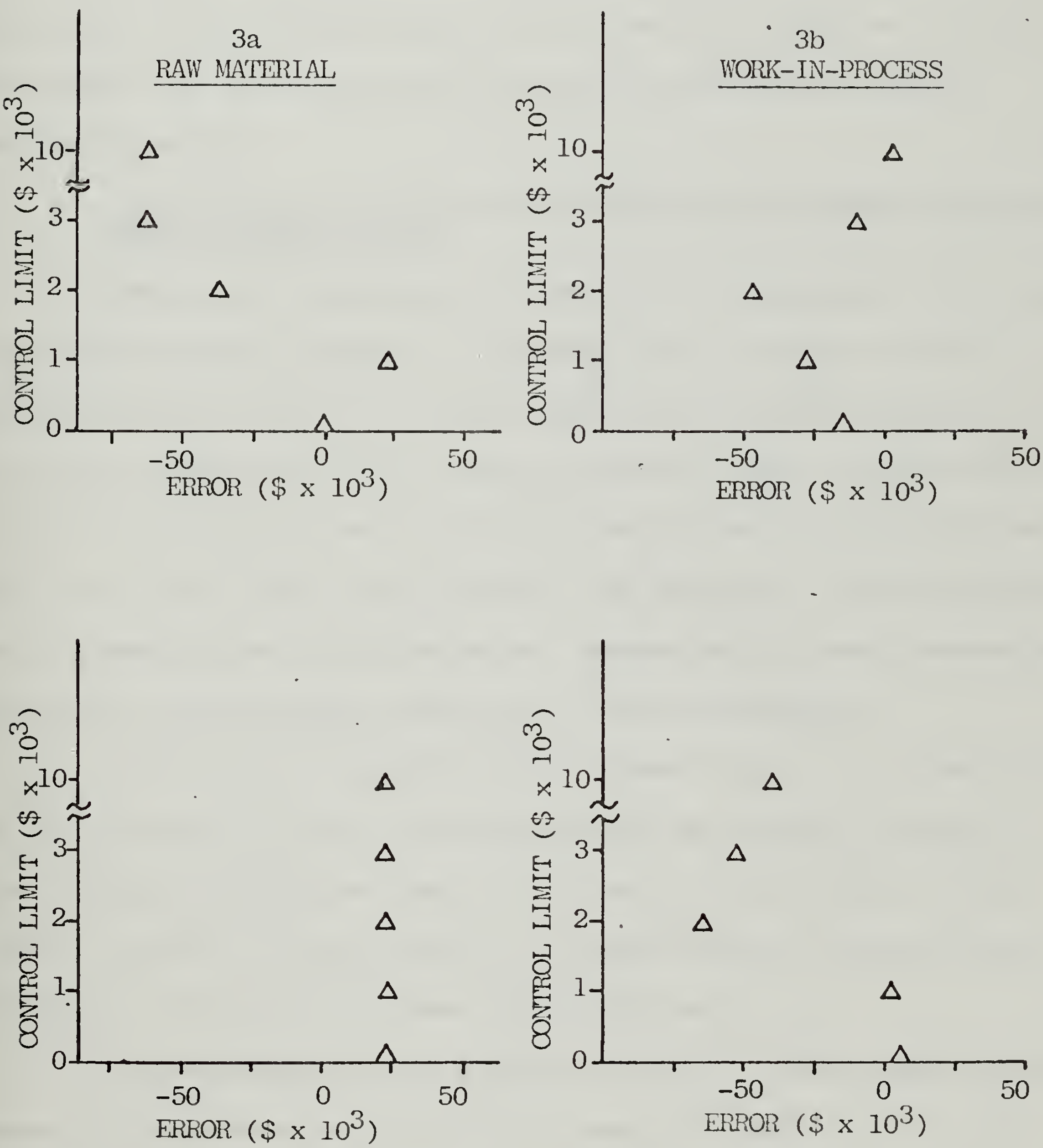
transferred to work-in-process to be inspected and counted if the extended dollar value of the transactions exceeded the previously-specified dollar thresholds. This step was combined with the previous one in order that a logical comparison could be made as additional accounting controls were applied to transactions in raw material receipt and transfer.

Figures C-13 through C-16, respectively, are the sets of distribution plots of the resultant net dollar errors in the ending inventories when the accounting control threshold is \$3,000, \$2,000, \$1,000, and \$0. Figure D-5 is a tabulation of the mean and standard deviation of each of these distributions.

The results of these tests are displayed in Fig. 3. As the accounting control limit is tightened from \$3,000 to \$2,000, more erroneous transactions are corrected by the control process. The mean of the distribution of the net resultant error in raw material inventory consequently decreases. However, a counter-intuitive result did occur in the case of the \$1,000 threshold. As shown in Fig. 3a, the mean error moves across the zero error point to a positive error before it is reduced to zero error for the \$0 control (i.e., with the \$0 control, the simulation model corrects every error related to raw materials transactions). The explanation is similar to that which explained in Fig. 2a in subparagraph D.1.a. above (i.e., at the \$1,000 control limit more understatements are being corrected than overstatements and the mean error shifts across the zero point).

FIGURE 3

LOCUS OF THE CHANGED MEAN OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES DUE TO ACCOUNTING CONTROLS (UNIT PRICING AND UNIT COUNT) APPLIED TO TRANSACTIONS IN RAW MATERIAL RECEIPT AND TRANSFER TO WORK-IN-PROCESS.



In Fig. 3c, the decoupling of finished goods transactions from raw materials transactions is shown by the constancy of the mean of the distribution of finished goods errors. Additionally, a comparison of Figs. C-13c, C-14c, C-15c and C-16c shows the distributions themselves to be identical.

As occurred in the previous test and as shown on Fig. D-5, the standard deviation of the distribution of error decreases for each inventory except finished goods which remains constant.

2. <u>Accounting Controls for Raw Materials, Work-In-Process and Finished Goods</u>

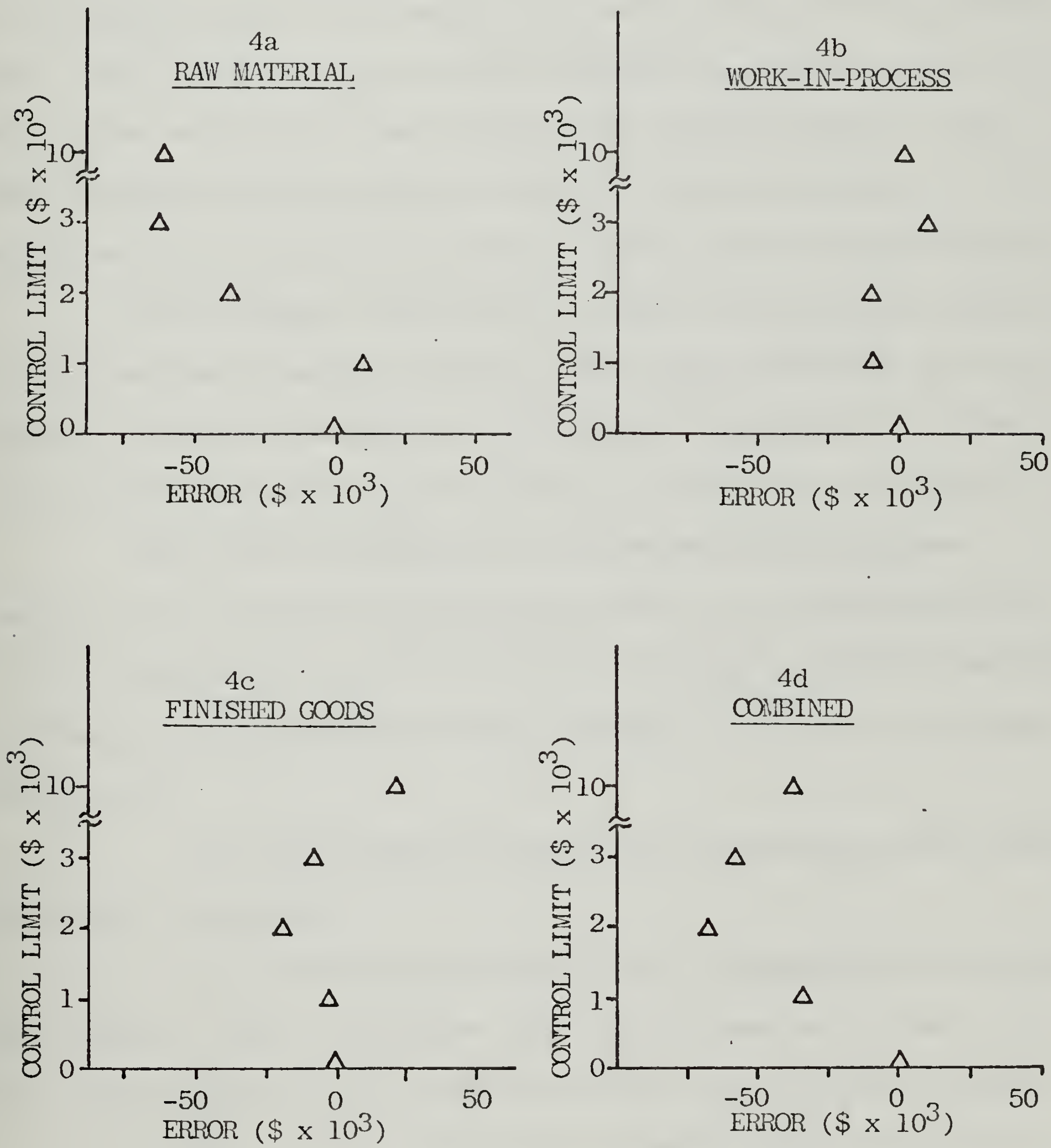
The next accounting controls to be introduced into the simulation model consisted of adding unit pricing and unit count controls for: (a) direct labor and factory burden inputs to work-in-process; and (b) unit standard cost transactions on completed production orders when transferred to finished goods. This is to say that any erroneous raw material, work-in-process or finished goods transaction was corrected if the transaction exceeded the previously-specified dollar threshold.

Figures C-17 through C-20, respectively, are the sets of distribution plots of the resultant net dollar errors in the ending inventories when the threshold is $3,000, $2,000, $1,000, and $0. Figure D-6 is a tabulation of the means and standard deviations of these distributions.

As depicted in the graphs of Fig. 4, the change in the means of the distribution of the resultant net dollar error behaved as expected. Figure 4a shows that, as the control

FIGURE 4

LOCUS OF THE CHANGED MEAN OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES DUE TO ACCOUNTING CONTROLS (UNIT PRICING AND UNIT COUNT) APPLIED TO TRANSACTIONS IN RAW MATERIAL, WORK-IN-PROCESS AND FINISHED GOODS.



limit is tightened, the net dollar error of the raw material ending inventory balance decreases in the same fashion as described in the analysis of the previous test. Figure 4c shows that finished goods transactions are now being corrected and there is no longer any constancy associated with the mean of the distribution of the resultant net dollar error in finished goods ending inventory. As previously pointed out in subparagraphs D.1.a. and D.1.b. above, Fig. 4c also shows that, for the $3,000 and $2,000 thresholds, more understatements are being corrected than overstatements and the mean error shifts from the positive side of the zero point to the negative side before decreasing to zero with the $0 threshold.

The standard deviations of the distributions monotonically decreased as the control limit was tightened from the $3,000 to the $0 threshold. At the $0 threshold, all transactions were checked and corrected if an error took place.

Fig. 5 is a summary set of graphs depicting the sensitivity of the standard deviations of the distributions of the resultant net dollar error in ending inventory balances to changes in accounting control limits. The set of graphs shows that:

1) The standard deviations decreased as the dollar threshold decreased.

2) The standard deviations decreased as the accounting controls were introduced into more inventory areas (i.e., from raw materials into work-in-process and finished goods).

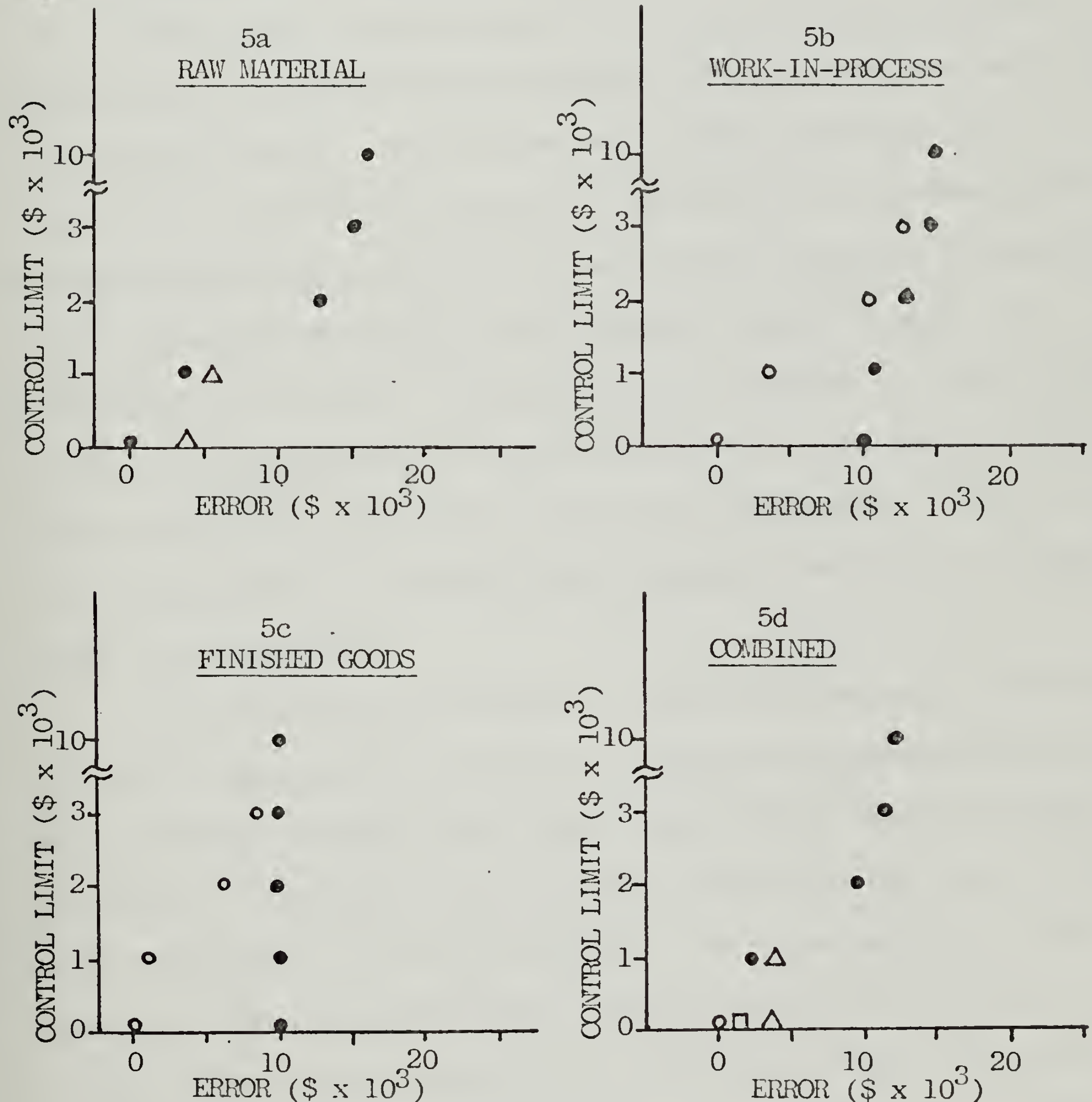
3) In some cases, the standard deviations for a

FIGURE 5

LOCUS OF THE CHANGED STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES DUE TO ACCOUNTING CONTROLS APPLIED TO TRANSACTIONS IN RAW MATERIAL RECEIPT AND TRANSFER TO WORK-IN-PROCESS AND TO TRANSACTIONS IN RAW MATERIAL, WORK-IN-PROCESS AND FINISHED GOODS.

LEGEND

△ - RAW MAT'L TRANSACTIONS (PRICING CONTROLS ONLY)
□ - RAW MAT'L TRANSACTIONS (PRICING AND UNIT COUNT CONTROLS)
○ - RAW MAT'L/W-I-P/FIN GOODS TRANSACTIONS (PRICING AND UNIT COUNT CONTROLS)
● - MERGED PLOT



particular ending inventory error at the same control limit were practically coincident and resulted in a "merged plot."

When Fig. 5 is examined in conjunction with Figs. 2, 3, and 4, it becomes evident that reliability, as defined in this thesis, improves not only as accounting controls are tightened but also as the controls are introduced into more accounting areas.

3. Weigh-Count for Finished Goods

The final accounting control to be tested was the weigh-count of completed production orders being transferred to finished goods. The procedure in the base case was to correct all production errors on transfer to finished goods if the difference between the weigh-count and the production order exceeded 20 units. The 20-unit control limit was tightened to 10 units. Figure C-21 is the set of distribution plots of the resultant net dollar error in the ending inventories when the weigh-count limit was decreased. Figure D-7 is a tabulation of the mean and standard deviation of each of these distributions.

As expected, the mean of the distribution of the error in the finished goods inventory decreased substantially because more erroneous production counts were being discovered and corrected. Likewise, the standard deviation of the finished good decreased, but only slightly. An examination of the errors in the finished goods ending inventory for each individual iteration disclosed that there were total net errors in the ending inventory ranging from -$32,000 to +$32,000.

However, the bulk of the weigh-count overstatements were corrected when the limit was tightened and the net effect was to have a mean of all of the iterations which was approximately zero.

E. INVESTIGATION OF ABSOLUTE ERRORS

1. Modification of the Model

In order to investigate the usefulness of the dual measure of reliability described previously in Section E of Chapter III, the computer simulation model was modified to accumulate the absolute dollar amount of each error committed by the model in completing one replication. As in the case of the accumulation of the resultant net dollar error in ending inventory balances: (a) the model was replicated 1500 times; (b) the total absolute dollar error was isolated for each replication; (c) a probability distribution for the 1500 replications was plotted; and (d) the mean and standard deviation was computed for each distribution.

The investigation was confined to the finished goods and combined ending inventories. This was done in order to determine:

1) The accumulation of absolute errors associated with an isolated ending inventory wherein transaction errors did not occur in both inputs to and outputs from the inventory. In the case of the finished goods inventory, errors were committed only to input transactions from work-in-process and not when finished goods were sold.

2) The totality of absolute errors committed throughout the entire accounting process (i.e., inputs to raw materials, outputs from raw materials into work-in-process and outputs from work-in-process into finished goods). This was the absolute error associated with the combined ending inventory.

2. The Base Case

Figure C-22 is the set of distribution plots of absolute dollar error in the finished goods and combined ending inventories. Figure D-8 contains the tabulation of the mean and standard deviation of these distributions. When compared with the mean of the distribution of the resultant net dollar error in ending inventories for the base case, it is significant to note the magnitude of the mean of the distribution of the absolute dollar error:

1) For the finished goods ending inventory, the mean of the distribution of the absolute error is $103,000 versus $21,000 for the net error.

2) For the combined ending inventory, the mean of the distribution of the absolute error is $381,000 versus -$38,000 for the net error.

In both of these cases, the absolute error figure indicated the degree of offsetting which was taking place. This was not apparent from the net error figure. The offsetting effect was a substantial one.

3. Accounting Controls for Raw Materials, Work-In-Process and Finished Goods

These controls were the same as those discussed in subparagraph D.2 above. Figures C-23 through C-26, respectively, are the sets of distribution plots of the absolute dollar error in the finished goods and combined ending inventory when the accounting control limits are \$3,000, \$2,000, \$1,000, and \$0. Figure D-8 is a tabulation of the mean and standard deviation of each of these distributions.

Figure 6 is a graph comparing the changed means of the distributions of the resultant net dollar error and the absolute dollar error in the finished goods and combined ending inventories due to changes in the control limit. As expected, the absolute error decreased monotonically to zero as the control limit was tightened. Figures 6b and 6d show this result.

Figure 7 is a graph comparing the change in the standard deviations of the distributions of the resultant net dollar error and the absolute dollar error in the same two ending inventories. Figure 7a shows that for the finished goods ending inventory, the standard deviation of the distribution of the absolute error is practically coincident with that for the net error. Unfortunately, the model was not designed to provide the statistical information necessary to investigate the underlying reason for this result. Consequently, the reason for this result remains a topic for future research.

Figure 7b shows that only when the control limit is tightened to \$1,000 for the combined ending inventory, does the standard deviation of the distribution of the absolute error approximate that of the net error.

FIGURE 6

LOCUS OF THE CHANGED MEAN OF THE DISTRIBUTION OF THE NET DOLLAR ERROR AND ABSOLUTE DOLLAR ERROR IN FINISHED GOODS AND COMBINED ENDING INVENTORIES DUE TO ACCOUNTING CONTROLS (UNIT PRICING AND UNIT COUNT) APPLIED TO TRANSACTIONS IN RAW MATERIAL, WORK-IN-PROCESS AND FINISHED GOODS.

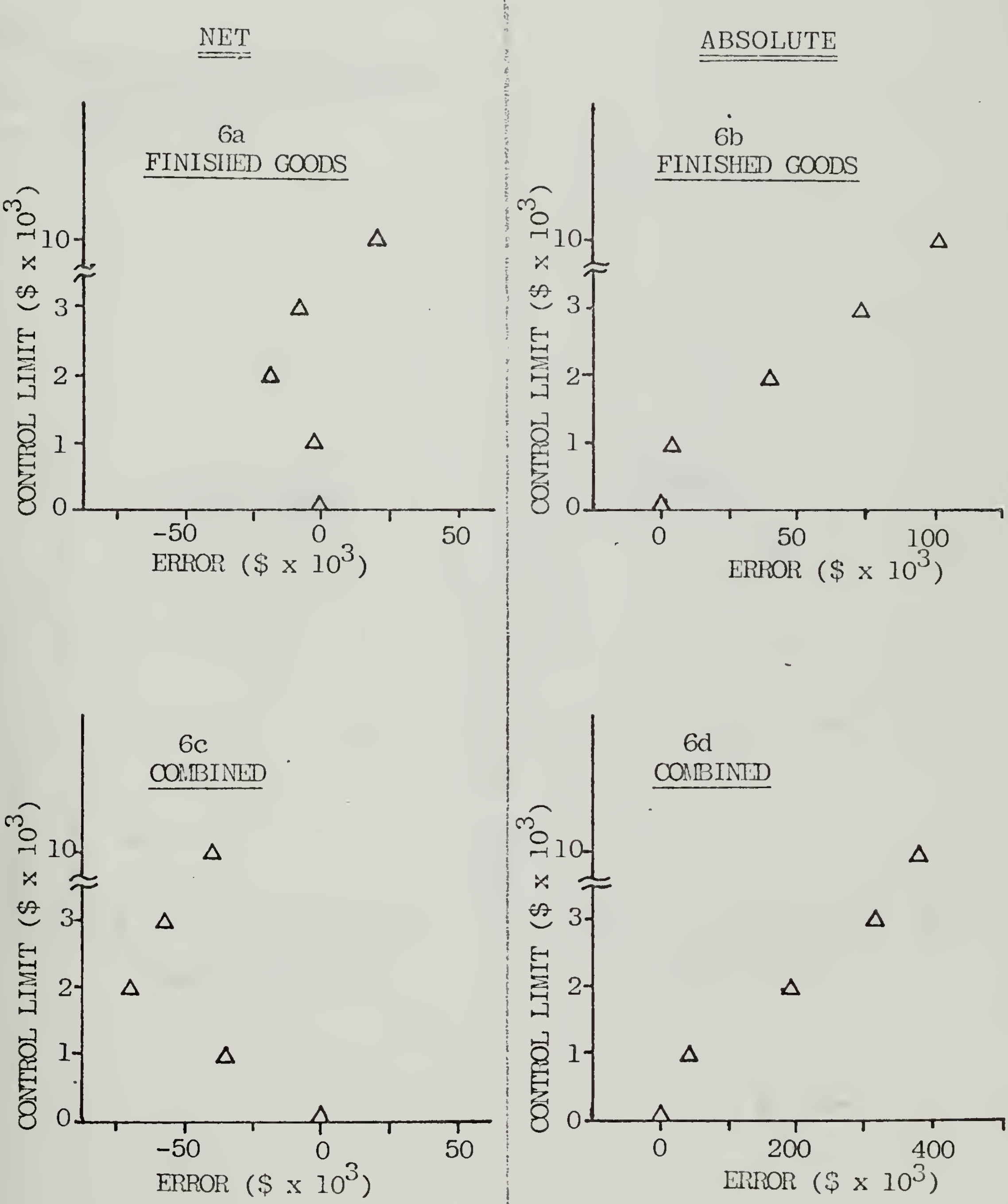
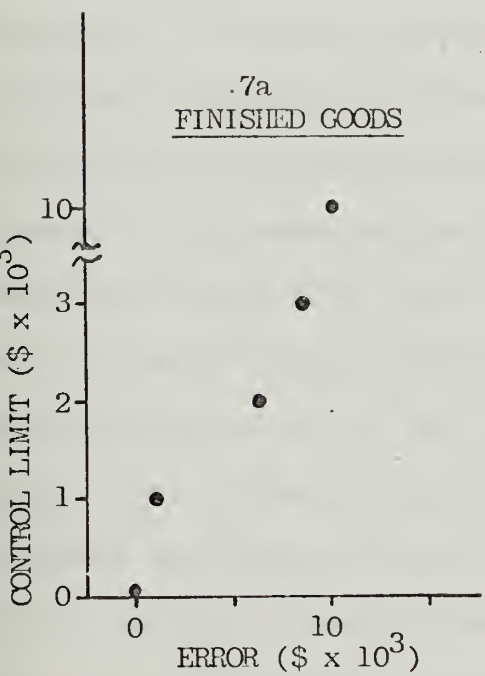


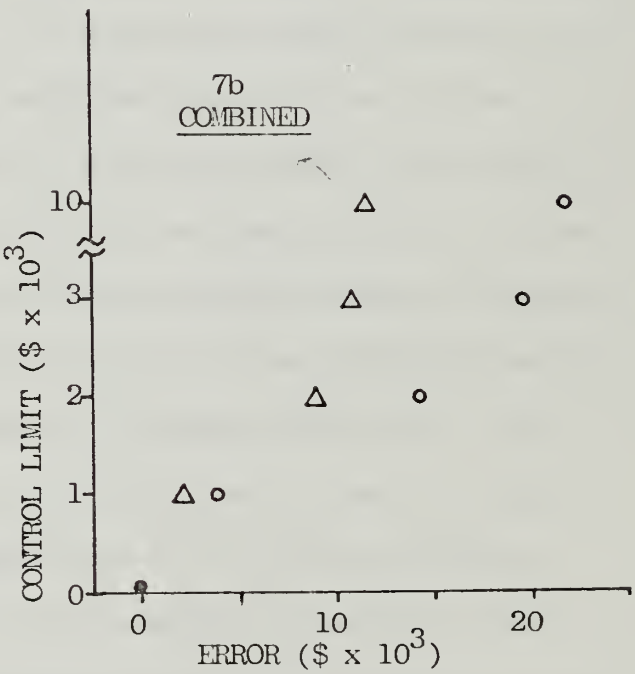
FIGURE 7

LOCUS OF THE CHANGED STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR AND ABSOLUTE DOLLAR ERROR IN FINISHED GOODS AND COMBINED ENDING INVENTORIES DUE TO ACCOUNTING CONTROLS (UNIT PRICING AND UNIT COUNT) APPLIED TO TRANSACTIONS IN RAW MATERIALS, WORK-IN-PROCESS AND FINISHED GOODS.

LEGEND

△ - NET DOLLAR ERROR
o - ABSOLUTE DOLLAR ERROR
● - MERGED PLOT





4. Changed Accounting Activity

Figure C-27 is the set of distribution plots of the absolute dollar error in the finished goods and combined ending inventory when the accounting activity is changed to four and one-half months. Figure D-9 tabulates the mean and standard deviation for each of these distributions. As expected, when compared with the base case, the means for both ending inventories were reduced approximately by one-half when the activity level was reduced by one-half.

However, the standard deviation of the distribution of the absolute errors did not behave in the same fashion as they did for the distribution of the net error. The standard deviation of the distribution of absolute dollar error in the finished goods inventory was smaller by a factor of the reciprocal of the square root of two as was the case with the change in the standard deviation of the distribution of the resultant net dollar error in finished goods ending inventory. In the case of the standard deviation of the distribution of the absolute error in the combined ending inventory, the square root of two factor did not apply as it had for the standard deviation of the distribution of the net dollar error. Again, the model was not designed to generate the detailed statistical information necessary to investigate the reason for this outcome. Hence, the underlying reason for this outcome remains a topic for further research.

V. CONCLUSIONS

A. GENERAL

The major conclusion of this thesis is that auditors could make more confident assessments of the impact of various types of recurring errors and irregularities on the reliability of accounting records generated by complex systems if they could perform sensitivity analyses on a computer simulation model of the system in question in a manner similar to that described in this thesis. Where several types of irregularities or errors are believed to occur in a complex accounting process, the model described in this thesis illustrates the utility of conceptualizing the account balances involved as a reservoir of error, with positive and negative errors flowing in and flowing out as a result of the dynamic interaction of many people, processes and procedures. The net error or level of error in the reservoir at any point in time depends on these people, processes and procedures and their interaction over time.[3]

Where accounting and control systems are complex, the model illustrates that curious interrelationships can exist

---

[3]Problems in development and validation of such a model are addressed in Professor Burns' dissertation, where the differences between control processes which model the perfect correction capabilities of the model and the imperfect correction capability of a man are assumed to be negligible.

which may cause the system to exhibit what systems analysts call negative cybernetic phenomena. For example, by implementing a promising internal control process such as checking the extended price of all transactions over a certain dollar threshold, the model tested in this thesis demonstrated that other natural pressures are simultaneously released in other facets of the system which help defeat the new process. This is the crux of the auditor's problem where complex accounting systems are involved. When one pressure or combination of pressures is lightened (erroneous extended prices are corrected above a certain dollar threshold), the result might be a substitution of a new problem for an old (more erroneous overstatements are corrected than understatements). As the sensitivity analysis illustrated, the new problem can be more difficult to solve or less tolerable to live with than the old one, or both.

B. PREDICTABILITY OF END RESULTS (ENDING INVENTORY ACCOUNT BALANCE ERROR) DUE TO CHANGES IN SYSTEM VARIABLES

The model tested in this thesis demonstrates that complex accounting systems may behave in a counterintuitive manner. If this behavior exists in the real world, the results of this thesis further indicate a need for a mathematical method of assessment rather than a subjective assessment of tolerable error rates. For example, when the internal control process was implemented into the model to correct the erroneous extended price of all raw material transactions over a certain dollar threshold, the average error in the raw material

inventory actually increased. Variance decreased with increasing controls, at first slowly, then rapidly at the $1,000 threshold. The result was not subjectively predictable. It is the researchers' opinion that subjective methods cannot adequately deal with many of the complex interactions which are inherent in existing accounting systems and that a quantitative measure via computer simulation yields greater accuracy in assessing reliability.

C. EXOGENOUS INPUT TESTS

1. Changed Input Distribution

The distributions from which the raw material shipments and production orders were generated were changed from normal distributions to exponentials and then to uniform distributions while keeping the distribution means constant.

Both the means and standard deviations of the distributions of the resultant net dollar error in the ending inventory balance, computed by the model, showed no substantial change when the results of the uniform distribution was compared to those of the normal. This result was expected because of the similarity of the uniform to the normal distribution when large numbers of replications are involved.

However, the model computed a significant difference in the mean error of the ending finished goods inventory when the results of the exponential distribution were compared to those of the normal. Similarly, the model computed substantial differences in the standard deviation of the error in all four of the ending account balances when the exponential was

compared to the normal. These differences were expected and are due to the greater degree of variability of the inputs generated from the exponential distribution. This result tends to indicate that the probabilistic nature of input transactions could affect the reliability of some accounting records. At the present time, auditors do not give a great deal of attention to the probabilistic nature of input data. Perhaps they should.

2. Changed Input Distribution Means

The mean of each of the three input distributions was doubled. In the model, this change had the effect of doubling the sizes of raw material shipments and production orders. The error computed by the model in the ending inventory balance for raw materials and work-in-process remained essentially unchanged, but it was substantially changed in the finished goods ending inventory balance for all three distributions. The large size of production orders and raw materials shipments resulted in larger transfers out of work-in-process to finished goods. This caused the weigh-count operator to discover and correct more and larger errors. The sensitivity of this area was not subjectively apparent. In practice, auditors are very interested in ascertaining the most sensitive facets of such subsystems because: (a) audit tests of these areas must be rigorously designed; and (b) improvements in these areas result in the largest payoff to both the client and the auditor. Simulation could assist the auditor in identifying these sensitive areas.

D. ENDOGENOUS PARAMETER TESTS

The accounting activity level was changed from the base case of nine months to eighteen months and then to four and one-half months. This had the effect within the model of doubling and reducing the business volume by one-half. The model reacted as expected to these changes (i.e., the mean was doubled when activity was doubled; and the standard deviation increased by a factor of the square root of two. Similarly, the mean was reduced by one-half when the activity was reduced by one-half, and the standard deviation was reduced by a factor of the reciprocal of the square root of two). Hence, there were no other substantial findings as a result of these tests.

E. ACCOUNTING CONTROL TESTS

The design of the model was modified to include representations of various accounting controls which corrected transaction errors if the transaction exceeded a certain accounting threshold. These thresholds were selected by the researchers and set at $3,000, $2,000, $1,000, and $0. It was anticipated that, as the dollar threshold decreased and consequently more erroneous transactions were corrected, the expected total error content in the system would be reduced. The results indicated that this anticipated result was generally the case. The most valuable finding resulting from these tests, however, was not that they confirmed the researchers' intuitive notions about system performance, but that they illustrated that the model was capable of giving the user an

idea of how much error is corrected by application of these dollar control thresholds. This type of information would be quite valuable to the auditor who must recommend changes in the system to his client.

The dollar threshold type of accounting control process was applied to the raw material ending inventory in conjunction with only a correction of the extended unit price. This combination yielded the counterintuitive result discussed in the opening paragraphs of this chapter. The mean error in the ending raw material account balance actually increased at the $3,000 and $2,000 threshold. The threshold was reduced to the $1,000 level; the mean was reduced as expected. This counterintuitive result was caused by the presence of more positive errors than negative errors in the higher value transactions, and therefore more negative error was permitted to prevail, until the $1,000 threshold was reached. Such counterintuitive circumstances would be extremely difficult to predict in the real world, because of the complex interaction of various internal controls. This further demonstrates the potential of computer simulation as an assessment tool and also casts additional doubt on the adequacy of current subjective assessment methods.

In subsequent replications of the model, controls over unit price and unit quantity in all four inventories were applied, and the results were substantially as expected. The greater the number of controls applied to price and quantity, the more accurate was the ending account balance. By

indicating the effects of proposed system changes on total system reliability, this model not only supported intuitive notions but also disclosed the invalidity of some expected results. This latter disclosure should serve as a warning to those who would make subjective predictions concerning the potential impact of proposed changed to complex systems. It is the researchers' opinion that in the case of complex systems, only a method such as the simulation model could give the auditor the necessary insight to recognize the total system implications of many proposed system changes.

F. ABSOLUTE ERROR

The model was modified to accumulate the absolute error generated by the system. The researchers feel that this absolute measure provides a more rational criterion for the purpose of evaluating the potential effectiveness of proposed system changes than does the net error measure. However, the potential attractiveness of a proposed system change should also be evaluated from the standpoint of its most likely impact on the accuracy (i.e., total net error content) of the accounting records. The net error measure seems to be the best indication of this accounting record impact.

From an audit standpoint, the net error measure seems best suited for internal control reliance decisions because it provides an objective systemic measure of expected accounting record accuracy. In placing reliance upon internal controls, most auditors seem to choose to take on the risk of assuming that errors will offset. The absolute error measure, on the

other hand, seems to provide a better reliability measure for the purpose of designing substantive auditing procedures, because it does not subject the auditor to the risk of assuming that errors will offset. Therein lies the value of the additional measure of reliability.

Accounting controls were introduced which corrected erroneous pricing and unit count transactions in raw material, work-in-process, and finished goods using the same dollar control thresholds as previously discussed. As expected, the absolute error decreased monotonically to zero as the control limit was tightened.

Accounting activity was decreased from nine months to four and one-half months. As expected, when compared with the base case, the means for the ending inventories were reduced approximately by one-half when the activity level was reduced by one-half. The standard deviation of the distribution of the absolute errors did not behave in the same fashion as it did for the distribution of net error in all cases. There was no set mathematical relationship which could be readily identified.

The researchers believe that the benefits derived from the sensitivity analyses on this model can be cost effective to any auditor. The predictive superiority of a mathematical model such as the subject simulation model over subjective methods currently employed by most auditors was clearly demonstrated. The researchers recommend that the simulation technique be field tested for possible later status as a generally-accepted auditing procedure.

APPENDIX A

DETAILED DESCRIPTION OF THE COMPUTER SIMULATION MODEL

A. THE FRAMEWORK OF THE SIMULATION MODEL

The framework of the model is a standard cost accounting computer program for raw materials, work-in-process, and finished goods inventories. The functions of the framework are:

1) Maintenance of the financial inventory account balances.

2) Vouchering raw material purchases.

3) Costing-out production reports.

4) Costing-out material requisitions.

5) Costing-out transfers of completed units from work-in process to finished goods inventory.

6) Costing-out sales.

The model's framework is designed to maintain two separate, but parallel, sets of inventory accounting records: a Reported set of records and a Control set of records. Thus, the framework processes each inventory accounting transaction twice--once to update the Reported records, and a second time to update the Control records.

As the model processes transactions to update the Reported records, processing errors occur at random. These errors remain undetected and affect the reliability of the Reported inventory account balances. However, when the model processes these same transactions to update the Control records, no processing errors occur. Hence, the Reported balances represent unreliable

balances generated by the hypothetical accounting system. The Control balances represent, in the terms of the reliability definition previously given, the results theoretically obtainable.

B. THE EXTERNAL INPUT GENERATORS

The following five types of external input data are processed by the simulation model:

1) Incoming shipments of raw materials.

2) Production orders.

3) Raw material requisitions.

4) Transfer tickets denoting the transfer of finished products from work-in-process to finished goods.

5) Sales data.

The simulation model generates one set of all of the above input data and then feeds this input set to the model for dual processing.

The shipments of raw materials and the production orders are generated using the Monte Carlo Direct Approach. The number of units of raw material contained in each shipment and the number of products in a production order are normally-distributed random variables. Parameters limit the total number of each type of raw material and product to be generated during the simulation time period.

C. THE ERRONEOUS ACCOUNTING OPERATIONS

The five weaknesses in internal accounting controls described in Section A of Chapter I, permit the processing

errors committed by various accounting operations of the system to remain undetected throughout the simulation time period. The accounting operations assumed to commit these errors are represented in the Reported record portion of the model as probabilistic processes. These probabilistic processes introduce random error into the Reported inventory account balances throughout the simulation time period as both understatements and overstatements. The total amount of error contained in each Reported ending inventory balance is isolated by subtracting each Control balance from the corresponding Reported balance.

The six types of processing errors represented in the Reported portion of the simulation model are as follows:

1) A 10% understatement in the receiving and inspection counts on 25% of the incoming raw material shipments.

2) Incorrect material price standards in vouchering 10% of the raw material purchases. A list of various inappropriate price standards is incorporated in the model as parameters. The model selects inappropriate standards from this list using random sampling.

3) Overstatement of the Department I production count by 10% on 15% of the production orders processed. A similar overstatement takes place in Department II.

4) Incorrect standard direct labor hours and burden rates are applied to 8% of the production reports processed. Incorrect direct labor wage rates are applied to 10% of the production reports processed. Incorrect material usage and

price standards are applied to 10% of the material requisitions processed. Inappropriate standards are handled using the same technique as was explained in 2. above.

5) The model transfers all completed production orders to finished goods at the Production count generated by Department II. However, the model corrects any production count previously overstated by more than 20 units. Appropriate accounting adjustments are made for these corrections.

6) The model applies inappropriate unit standard costs to 8% of the completed orders transferred to finished goods.

The computer random number generator is used to trigger the specific random occurrence of each of the errors described above. Hence, the total error which results in each of the Reported ending inventory balances is a complex random variable.

D. THE PARAMETERS OF THE MODEL

The parameters of the model consist of the following items:

1) A file of correct standard cost information. This file consists of the data presented in Fig. 1, Chapter II.

2) A file of incorrect (erroneous) standard cost information. This file consists of information which is assumed to represent either a misfiled or an out-of-date version of the information given in Fig. 1, Chapter II.

3) The arithmetic means and standard deviations for the external input generators.

4) Beginning inventory levels. These figures contain no error and are used for both the Reported and Control records.

5) Quantities which limit the total volume of financial accounting activity to be processed during the nine month time period. These parameters are summarized in the format of a Cost of Goods Sold statement in Fig. A-1.

E. ADDITIONAL COMPUTER ROUTINES

In order to achieve a measure of reliability which would depict what errors could have caused the ending inventories described, the following computer routines were included in the simulation model:

1) A routine to replicate the nine months of business activity 1500 times and thus generate a different set of random numbers on each replication.

2) A set of statistical routines to sort the dollar error in each Reported balance into $1,000 error frequency intervals by type of inventory and calculate the probability distribution of the potential error in each category.

3) A set of routines to plot separately the probability distribution of each category of inventory -- raw material, work-in-process, finished goods, and combined.

4) A set of routines to calculate the mean and variance of the probability distribution.

FIGURE A-1

COST OF GOODS SOLD STATEMENT
FOR THE NINE MONTH ACCOUNTING PERIOD
(all figures are given at Standard Cost)

Raw material inventory, beginning of period	$ 339,100.
Raw material purchases during the nine-month period	1,584,800.
Raw material to be accounted for	1,923,900.
Raw material inventory, end of period	473,500.
Raw materials used	1,450,400.
Direct labor cost	87,183.
Factory overhead cost	417,497.
Total manufacturing costs	1,955,080.
Add: Work-in-process inventory, beginning of period	0.
	1,955,080.
Less: Work-in-process inventory, end of period	220,285.
Cost of goods manufactured	1,734,795.
Add: Finished goods inventory, beginning of period	283,809.
Cost of goods available for sale	2,018,604.
Less: Finished good inventory, end of period	287,490.
Cost of goods sold	$1,731,114.

APPENDIX B

OPERATIONAL FLOW CHART
OF THE SYSTEM SIMULATION MODEL

Dimension computer memory for all subscripted variables.

↓

Initialize subscripted variables to zero.

↓

Establish beginning inventories of raw materials work-in-process and finished goods at proper levels.

↓

Set parameters for the total units of each of the four types of raw materials to be received during the period, the total units of each of the four types of products to be produced during the period, and the total units of each of the four products to be transferred from work-in-process into finished goods inventory during the period.

↓

Establish correct and erroneous standard costs for each of the four types of raw materials.

↓

Establish correct and erroneous material, labor, burden, and total unit standard costs for each of the four types of products to be produced.

↓

Initialize work-in-process material, labor, and burden accumulators to zero.

↓

Set parameters establishing the mean and standard deviation of shipment sizes for each of the four types of raw materials to be received. Shipment sizes are assumed to be normally distributed.

↓

Generate the number of units shipped for each individual raw material shipment from a normal distribution in accordance with the shipment size parameters previously established. For each type of raw material, continue to generate individual shipments until the accumulated total number shipped, of each of the four types of raw materials, equals the respective parameter limiting the total units to be received during the period.

↓

Simulate the preparation of the receiving form by the receiving and inspection department by processing each shipment previously generated. Cause errors to occur in the recording of the quantity of goods received on the receiving form.

↓

Simulate the procedures employed by the purchasing agent in applying raw material price standards to the purchase order. Cost each receiving report previously generated and cause errors to occur in the application of raw material price standards. Maintain a CONTROL record over the errors generated by the receiving and inspection operation and the costing operation by applying correct standard material costs to original shipments previously generated.

↓

Extend the quantity received, recorded on each receiving report, by the standard material cost previously generated. Update the REPORTED raw material inventory by adding the accumulated amount of all extended receiving forms processed to the beginning raw material inventory. Extend all shipments received by the appropriate correct standard material cost. Update the CONTROL raw material inventory by adding the accumulated amount of all extended receiving forms processed to the beginning raw material inventory CONTROL record.

↓

Generate the number of units actually produced for each production order processed during the period. The size of production orders is assumed to follow a normal distribution with mean of 150 units and at standard deviation of 35 units. For each of the four types of products, production orders are generated until the accumulated quantity produced equals the previously established parameter limiting the total units to be produced during the period.

↓

Simulate the preparation of job time tickets applying to each production order. Reprocess each production order quantity, previously generated, and generate production counts for Departments I and II applicable to the production order. The simulation process is designed to overstate some production counts generated. These errors occur in accordance with pre-defined probability distributions. The production counts generated are assumed to be those noted on the job time tickets prepared by Departments I and II.

↓

Simulate the procedures employed by the cost accounting department in applying labor and burden standards to the job time tickets. Direct labor and burden standards are applied to each job time ticket. Errors occur in the application of standards in accordance with pre-defined probability distributions. Maintain a CONTROL record over the errors generated by the production count operation and the costing operation by applying appropriate correct labor and burden standards to the production orders previously generated.

↓

Update the REPORTED work-in-process inventory for labor and burden charges resulting from the processing of job time tickets generated for Departments I and II. This is accomplished by extending the reported production count on each job time ticket by the labor and burden standards applied and accumulating the extended labor and burden charges for all time tickets processed. Update the CONTROL work-in-process inventory in a similar manner by extending the actual production quantities generated for each production order by correct standard costs.

↓

Generate actual material usage for each production order manufactured during the period. Actual material usage is assumed to equal target for the actual quantity produced for each production order. No scrap or spoilage is assumed to occur.

↓

Generate the quantity of raw materials requisitioned for each production order manufactured during the period. This quantity is always the same as the production count recorded by Department I. It is assumed that excessive raw materials are requisitioned and used to cover overstated production reporting. Excessive materials not used in production are assumed to be returned to raw material stores by the machine operators. These returns are unauthorized.

↓

Simulate the procedure employed by the cost accounting department in applying raw material standards to raw material requisitions. Errors occur in the application of standards to material requisitions in accordance with pre-defined probability distributions. Maintain a CONTROL record over the errors caused by faulty reporting of quantities of raw material used in production and the application of erroneous standard costs. Apply correct raw material standards to the actual raw material usage figures previously generated.

↓

Update the REPORTED raw materials and work-in-process inventories by accumulating the extended quantity of raw materials requisitioned for each production order. This process assumes that machine operators in Department I always report production counts equal to the number of units of material they requisition for an order. Update the CONTROL raw materials and work-in-process inventories by accumulating the extended CONTROL quantity of materials used to produce each production order.

↓

Simulate the weigh-count operations involved in transferring production orders from work-in-process inventory to finished goods. Process and transfer all production orders-in-process, for each of the four types of products, up to the point where the accumulated total units of each product actually transferred equals the limit established for the total units to be transferred during the period. The remaining units not transferred are assumed to be fully complete but not formally transferred. Erroneous reporting in the weigh-count operation is simulated by transferring all production orders, not containing a production miscount of more than 20 units, at the erroneous production count figures. All orders containing a production count error in excess of 20 units are adjusted to the correct count and then transferred.

↓

Simulate the cost accounting procedures employed in applying standard costs to production orders transferred to finished goods. Errors occur in the application of standard costs to production orders transferred in accordance with pre-defined probability distributions. Errors also occur in adjusting for production count errors noted by the weigh-count operation. Work-in-process material, labor and burden accounts are adjusted as if the total production count error originated in Department I. Maintain a CONTROL record over the errors caused by faulty production reporting and cost accounting operations by applying the correct standard cost to the actual quantity of goods transferred for each production order.

↓

Update the REPORTED work-in-process and finished goods inventories by accumulating the unreliable extended value of the goods reported as transferred on each production order. Work-in-process inventory is credited for material labor, and burden and finished goods is charged with full standard cost. Adjustments are also made for production count errors noted by the weigh-count operation. Update the CONTROL work-in-process and finished goods inventories by accumulating the CONTROL extended value of the actual units transferred.

↓

Print the ending REPORTED and CONTROL inventory balances.

↓

Replicate the model 1500 times.

↓

Calculate the mean and standard deviation of the distribution of the dollar error in ending inventory balances from the 1500 replications.

↓

Plot the probability distribution of the dollar error in the ending inventory balances.

FIGURE C-1A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
BASE CASE

* * * * * * *

STANDARD DEVIATION = $ 16264.39
MEAN = $-61664.45

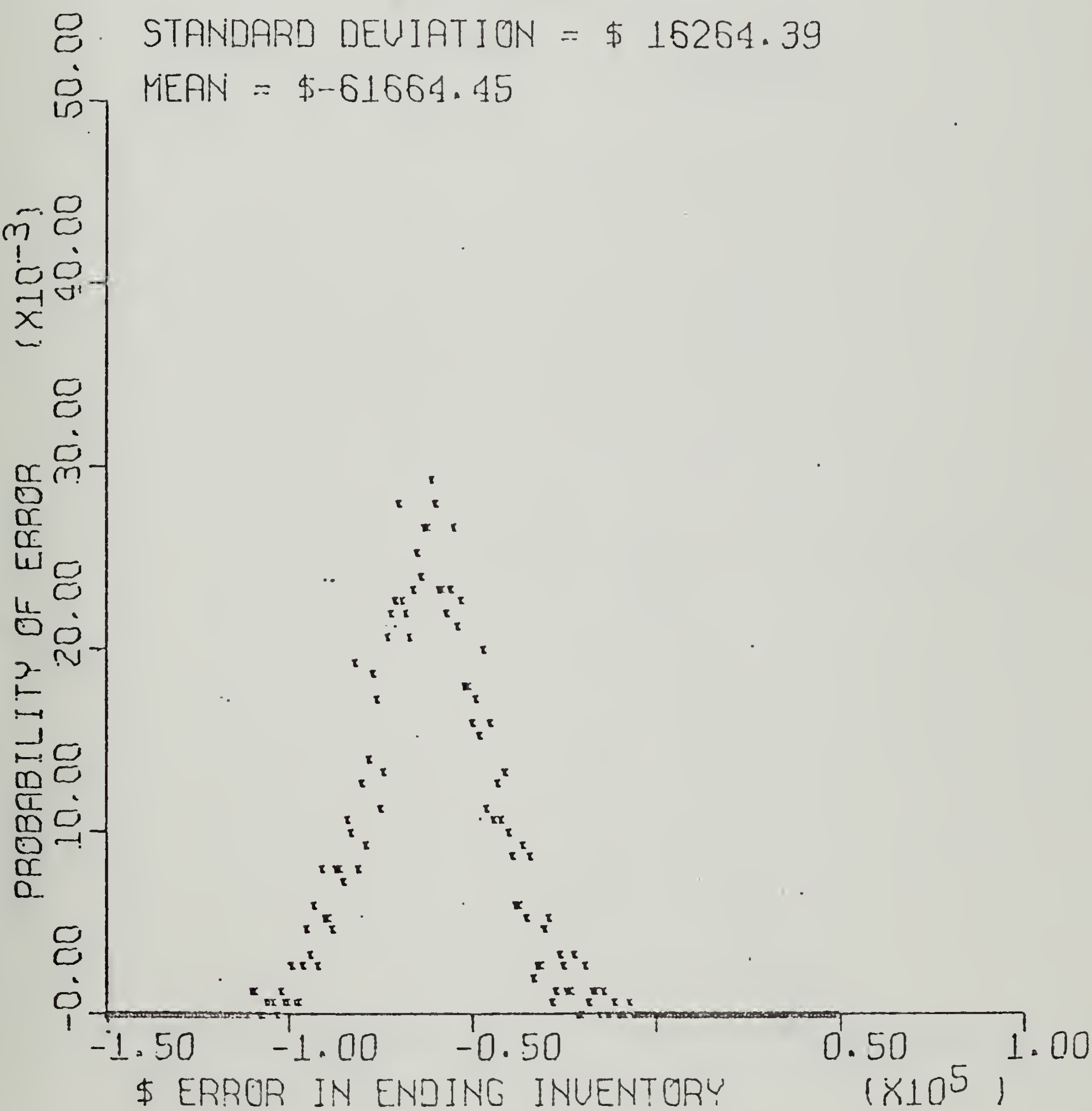


FIGURE C-1B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
BASE CASE

* * * * * * *

STANDARD DEVIATION = $ 14895.14
MEAN = $ 1383.29

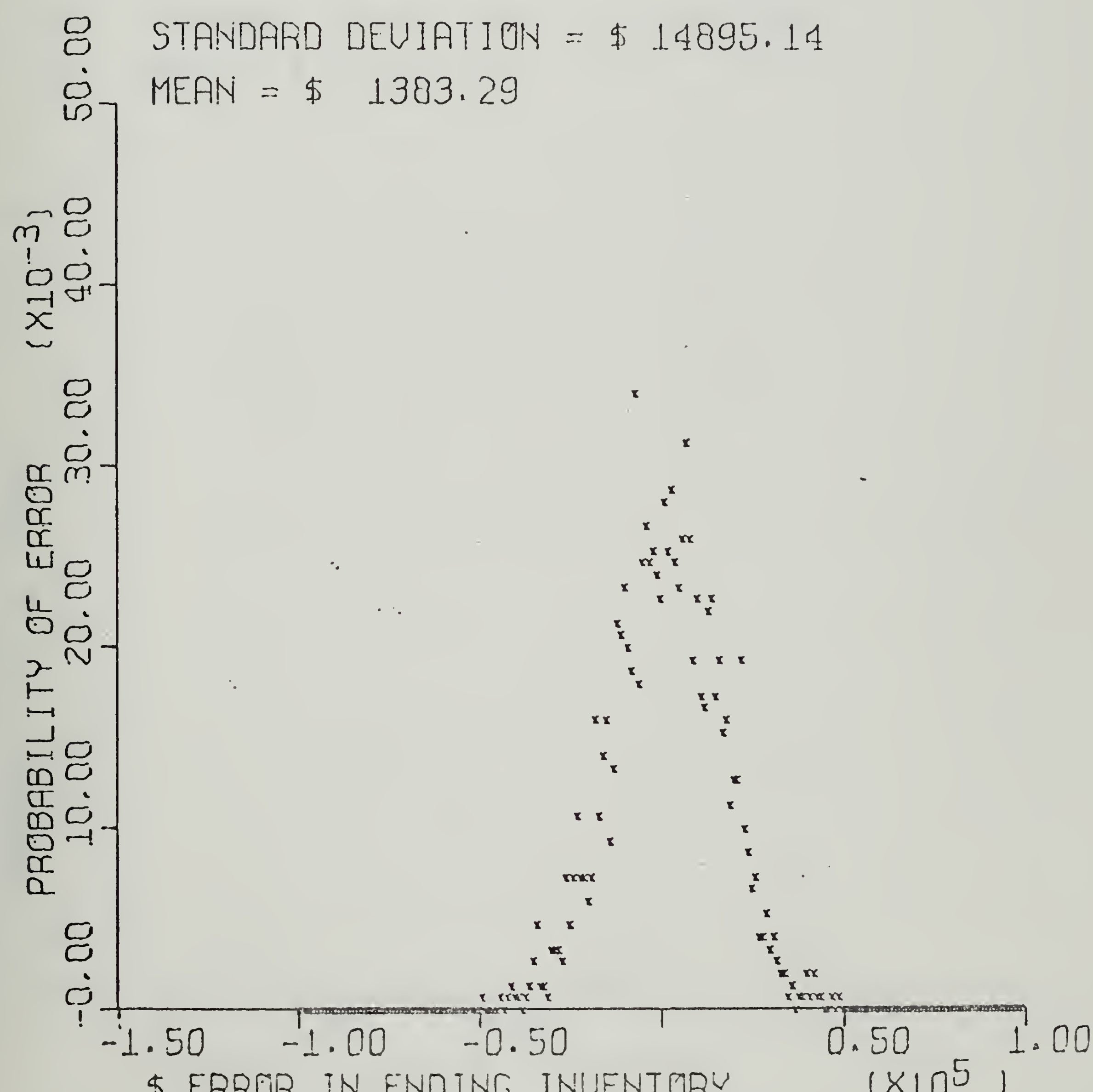


FIGURE C-1C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
BASE CASE

* * * * * * *

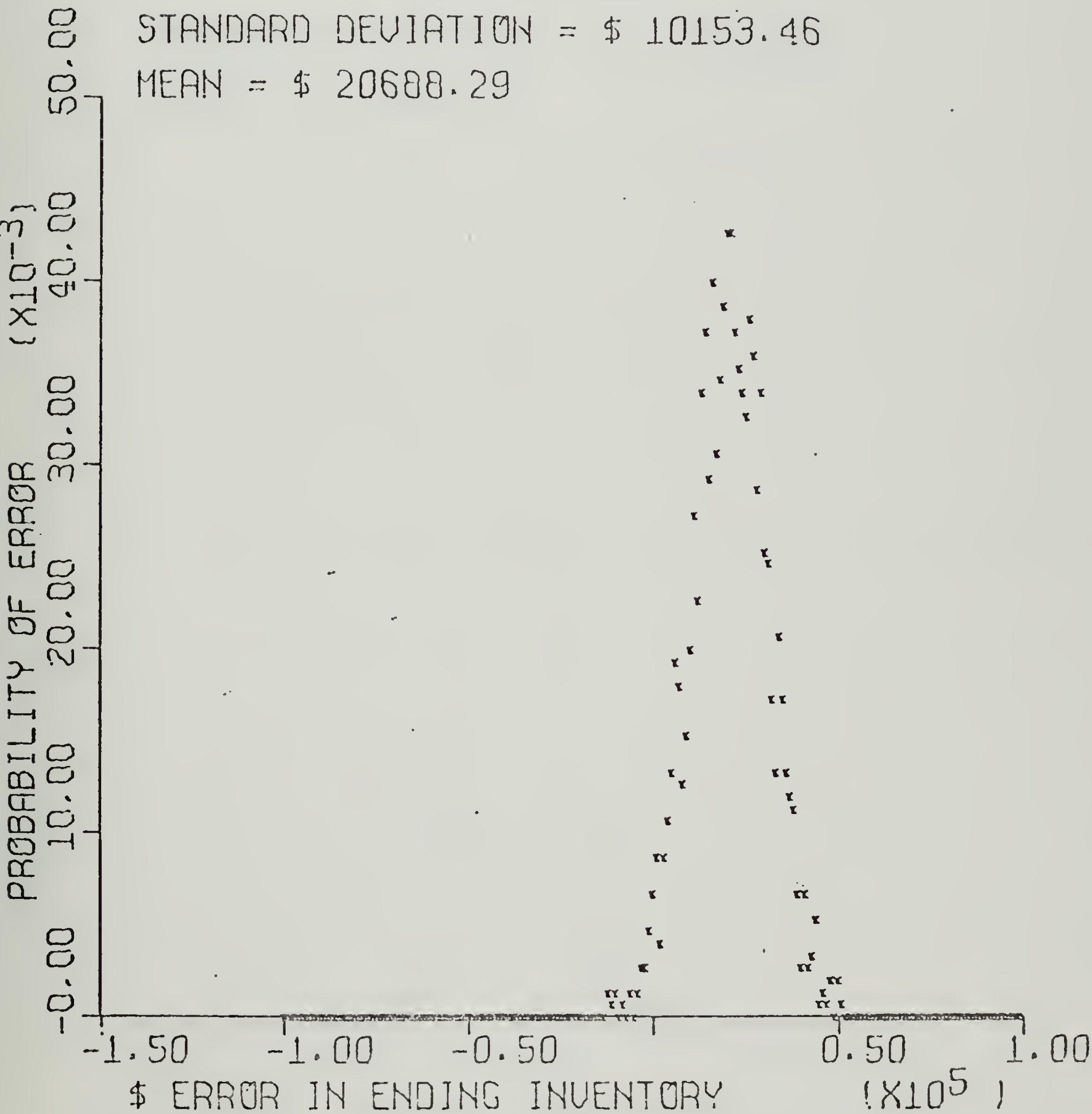


FIGURE C-1D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
BASE CASE

* * * * * * *

STANDARD DEVIATION = $ 11968.89
MEAN = $-38595.61

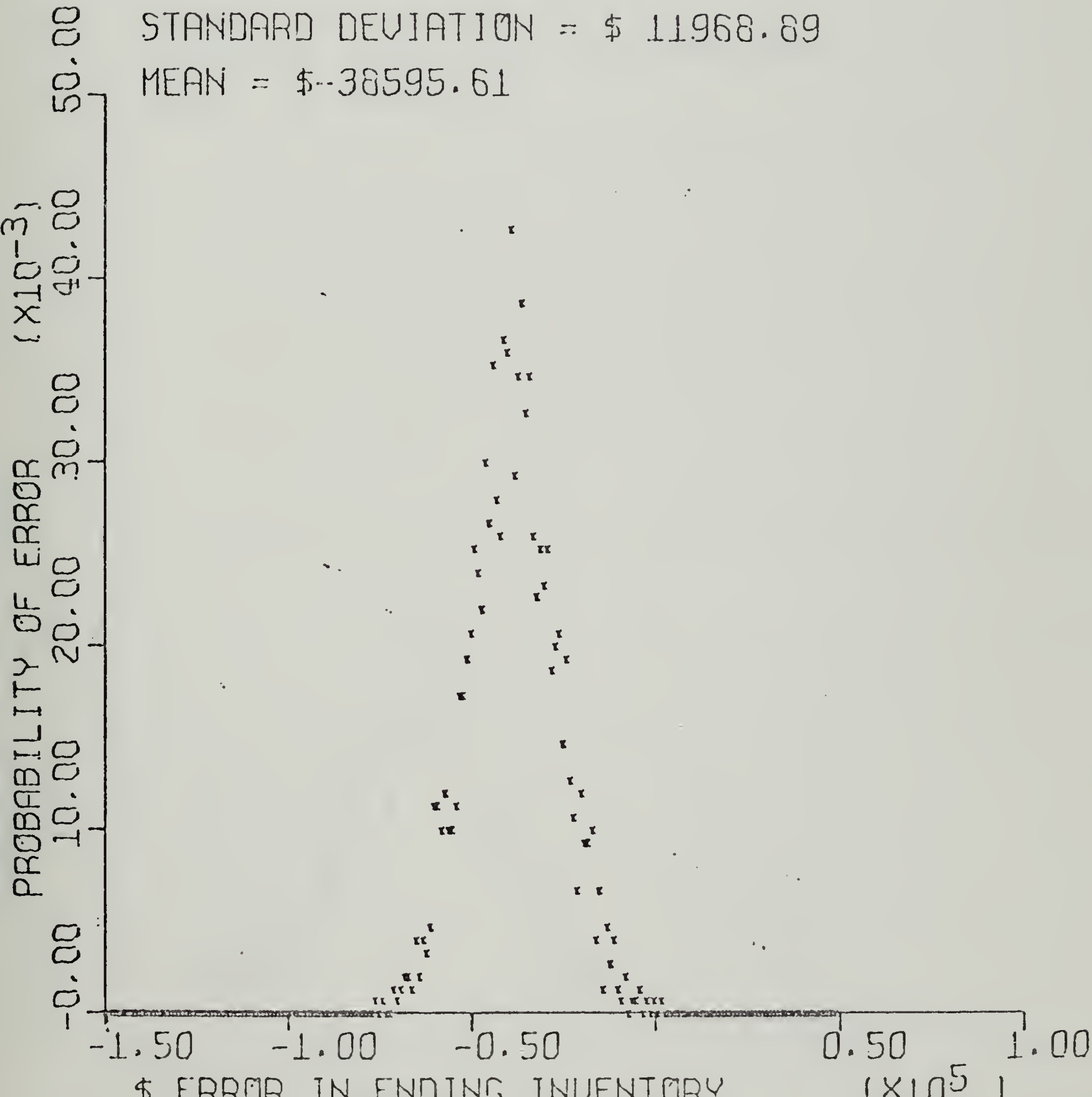


FIGURE C-2A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL

* * * * * * *

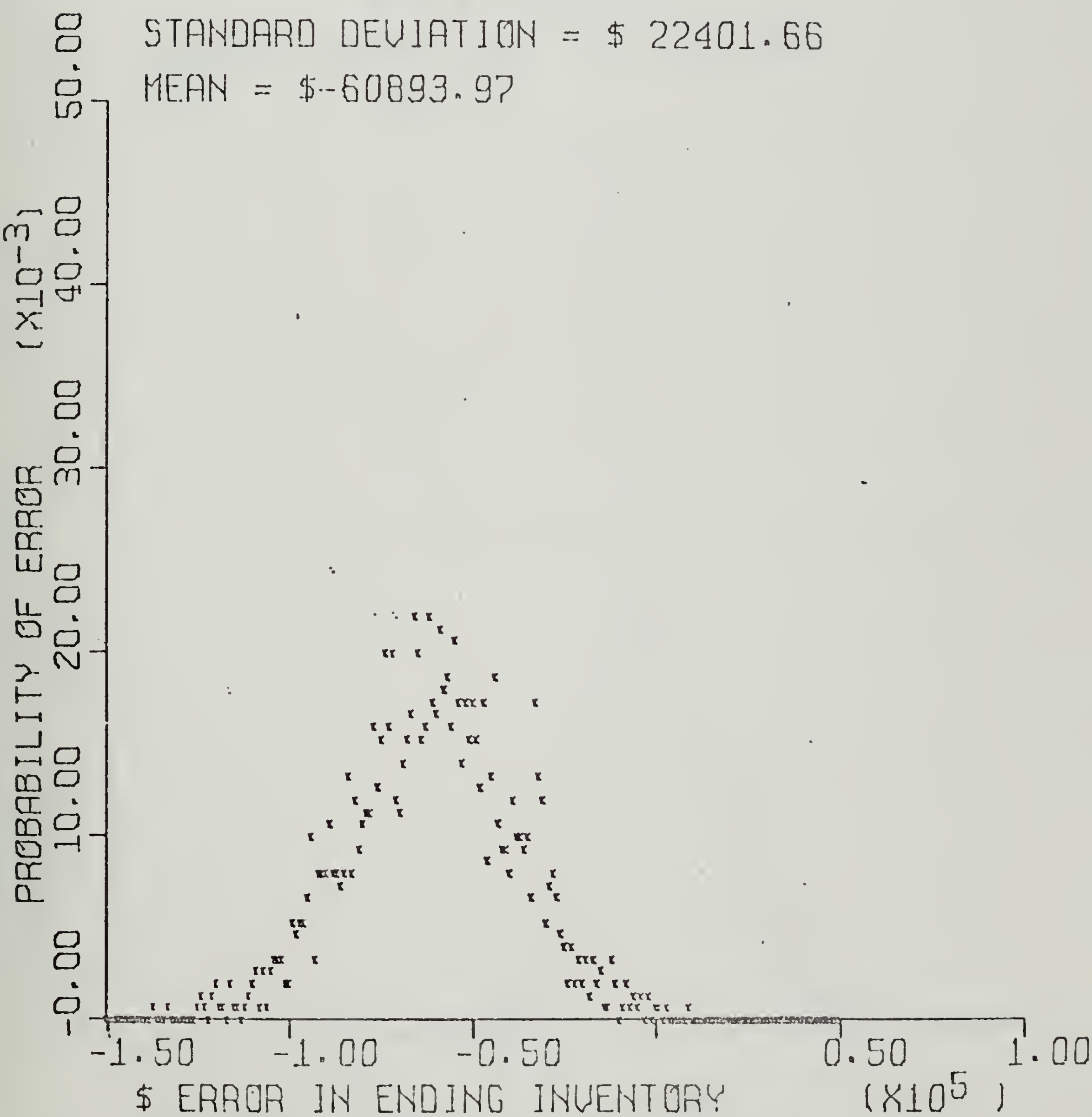


FIGURE C-2B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL

* * * * * * *

STANDARD DEVIATION = $ 18765.65
MEAN = $ 591.08

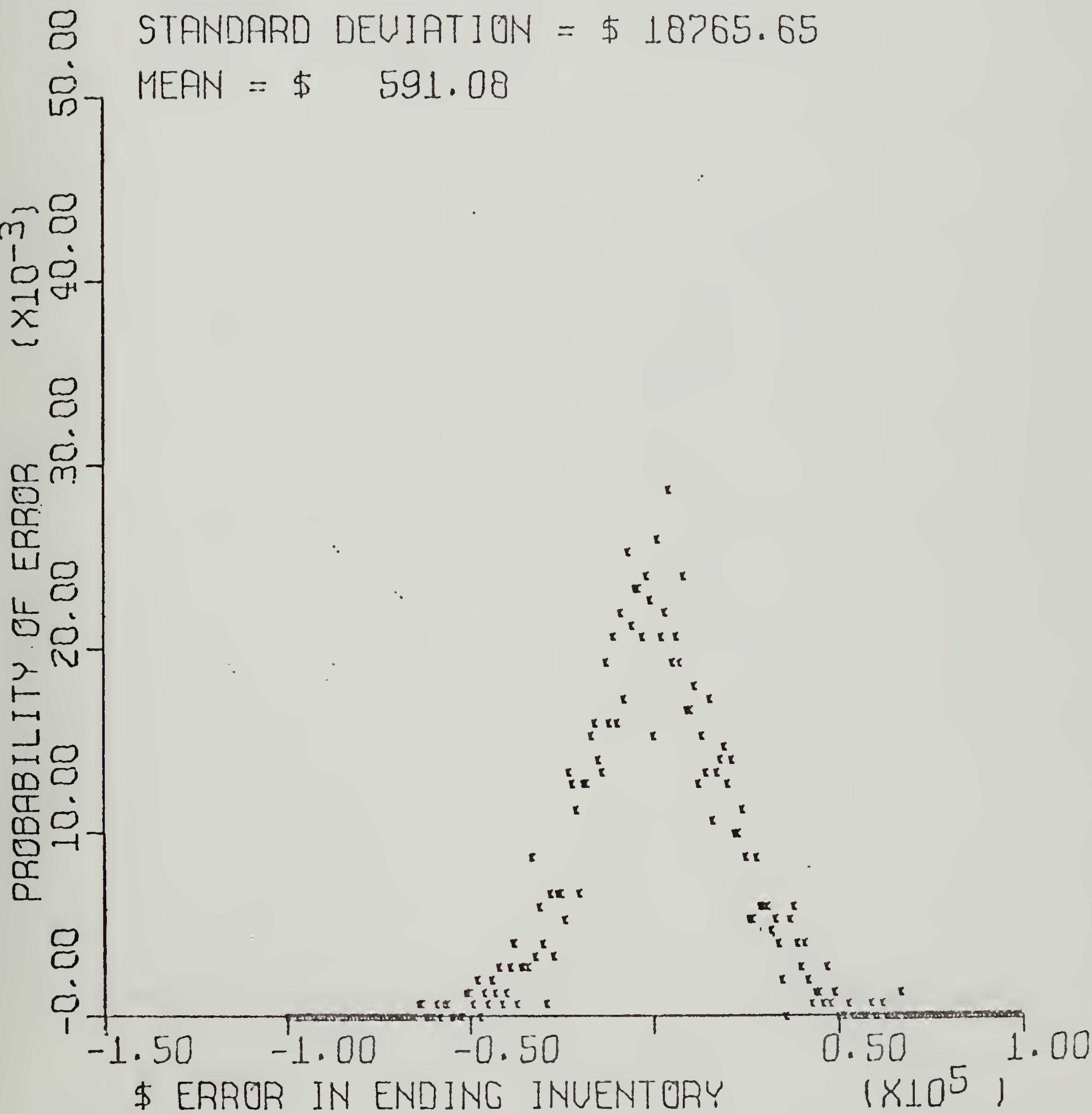


FIGURE C-2C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL

* * * * * * *

STANDARD DEVIATION = $ 12356.26
MEAN = $ 7087.84

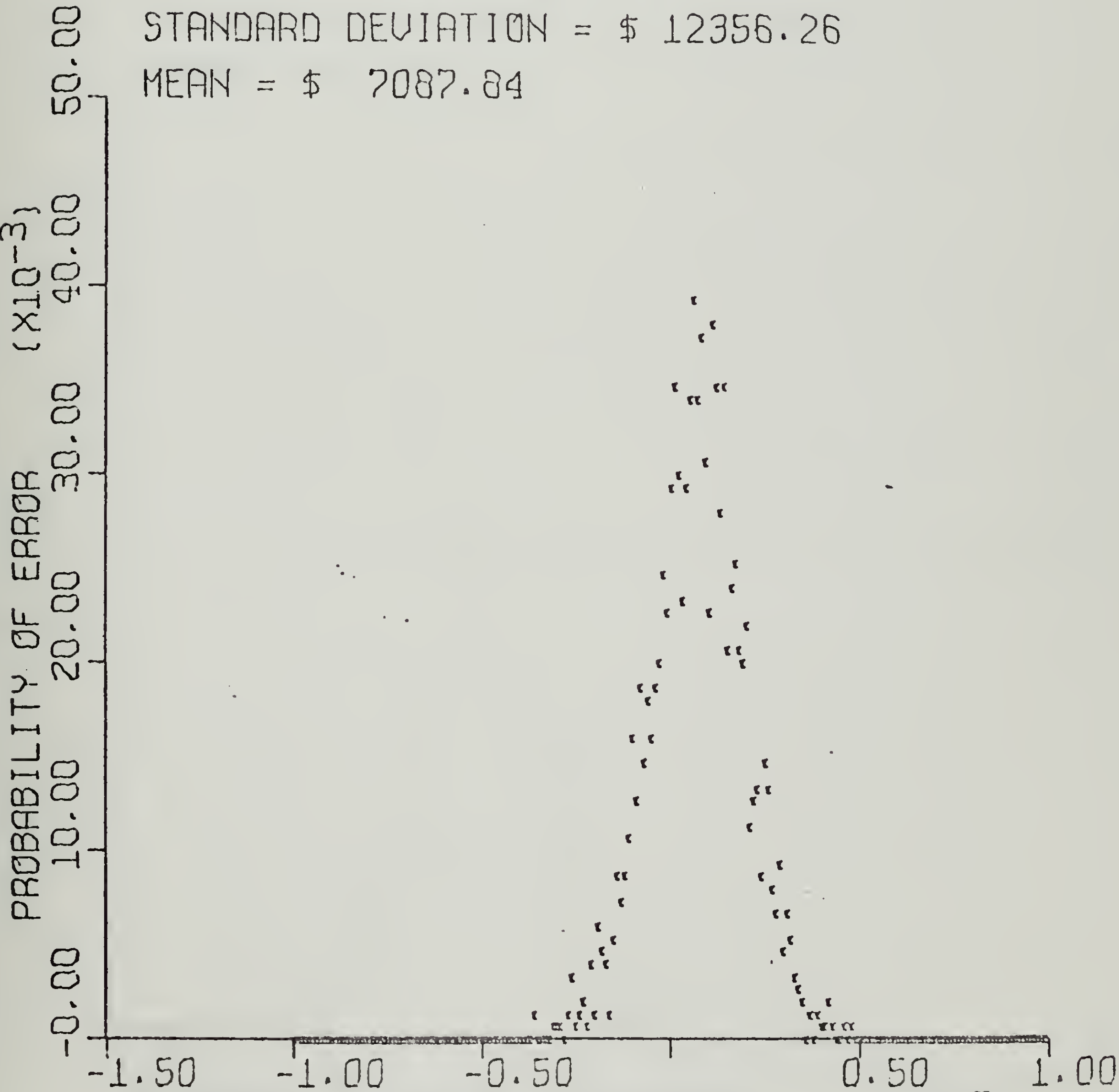


FIGURE C-20

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL

* * * * * * *

STANDARD DEVIATION = $ 17343.25

MEAN = $-52213.54

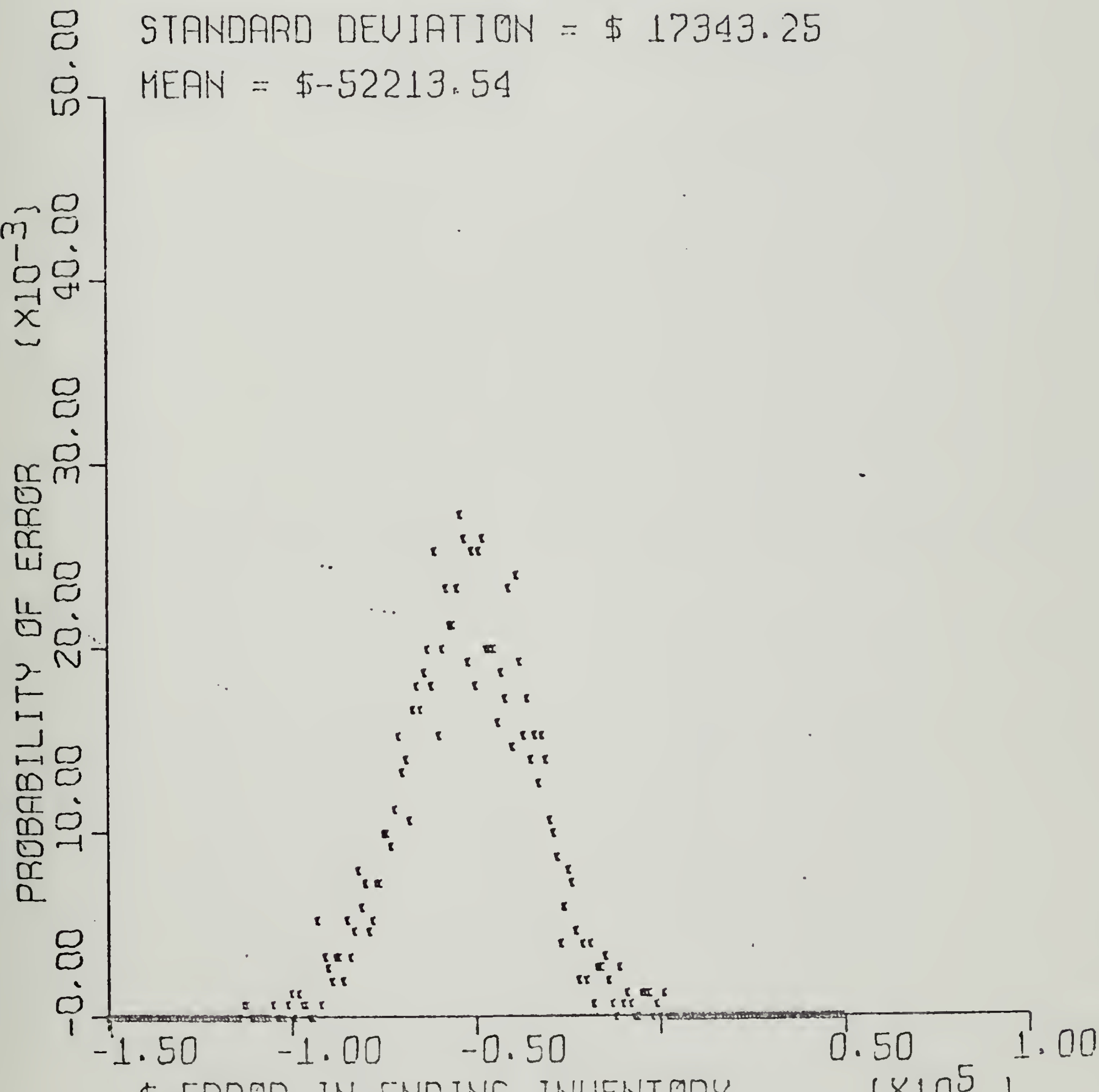


FIGURE C-3A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM

* * * * * * *

STANDARD DEVIATION = $ 15679.82

MEAN = $-60290.70

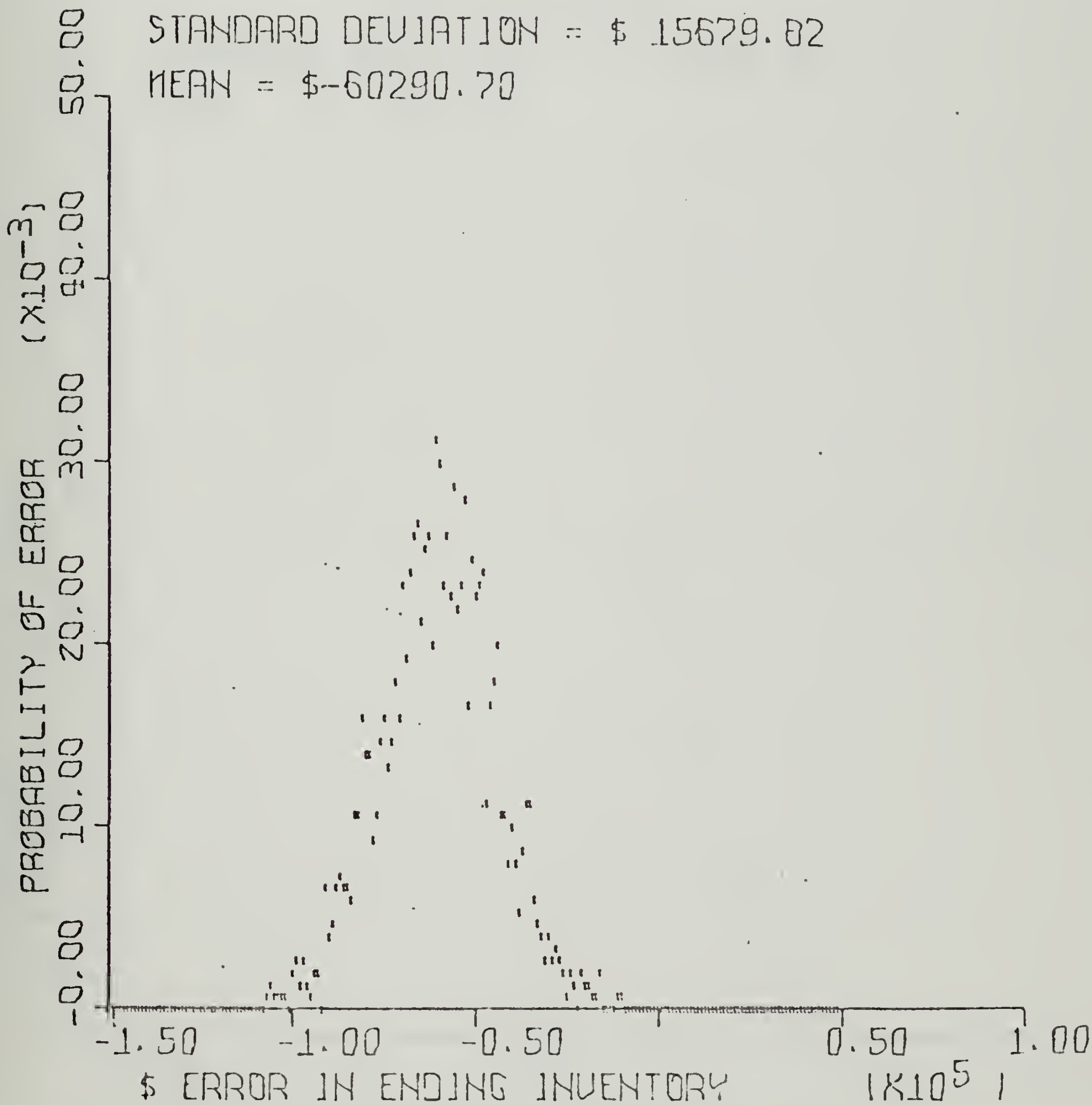


FIGURE C-3B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM

* * * * * * *

STANDARD DEVIATION = $ 14360.27

MEAN = $ 163.62

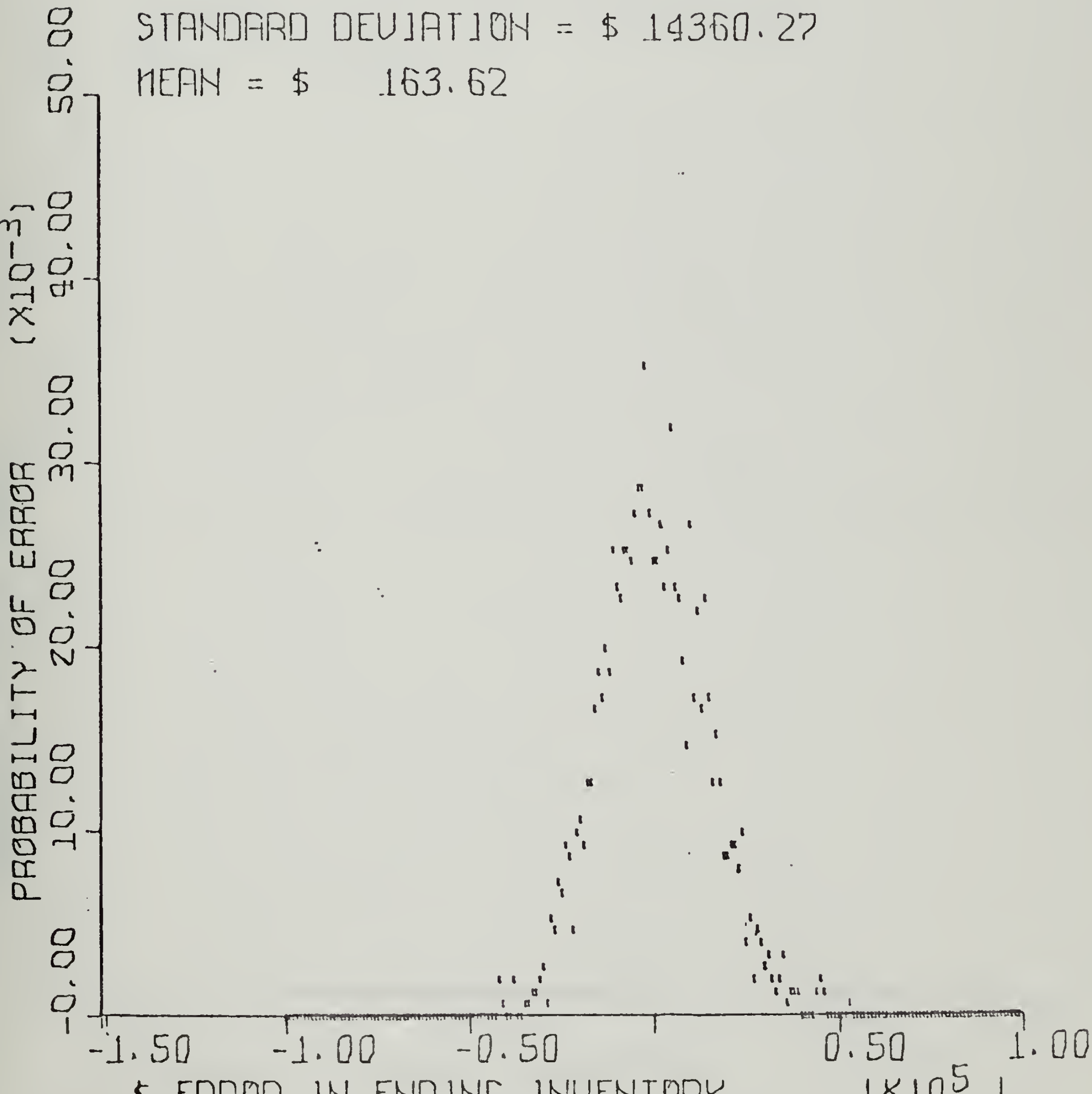


FIGURE C-3C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM

* * * * * * *

STANDARD DEVIATION = $ 10016.39

MEAN = $ 22604.44

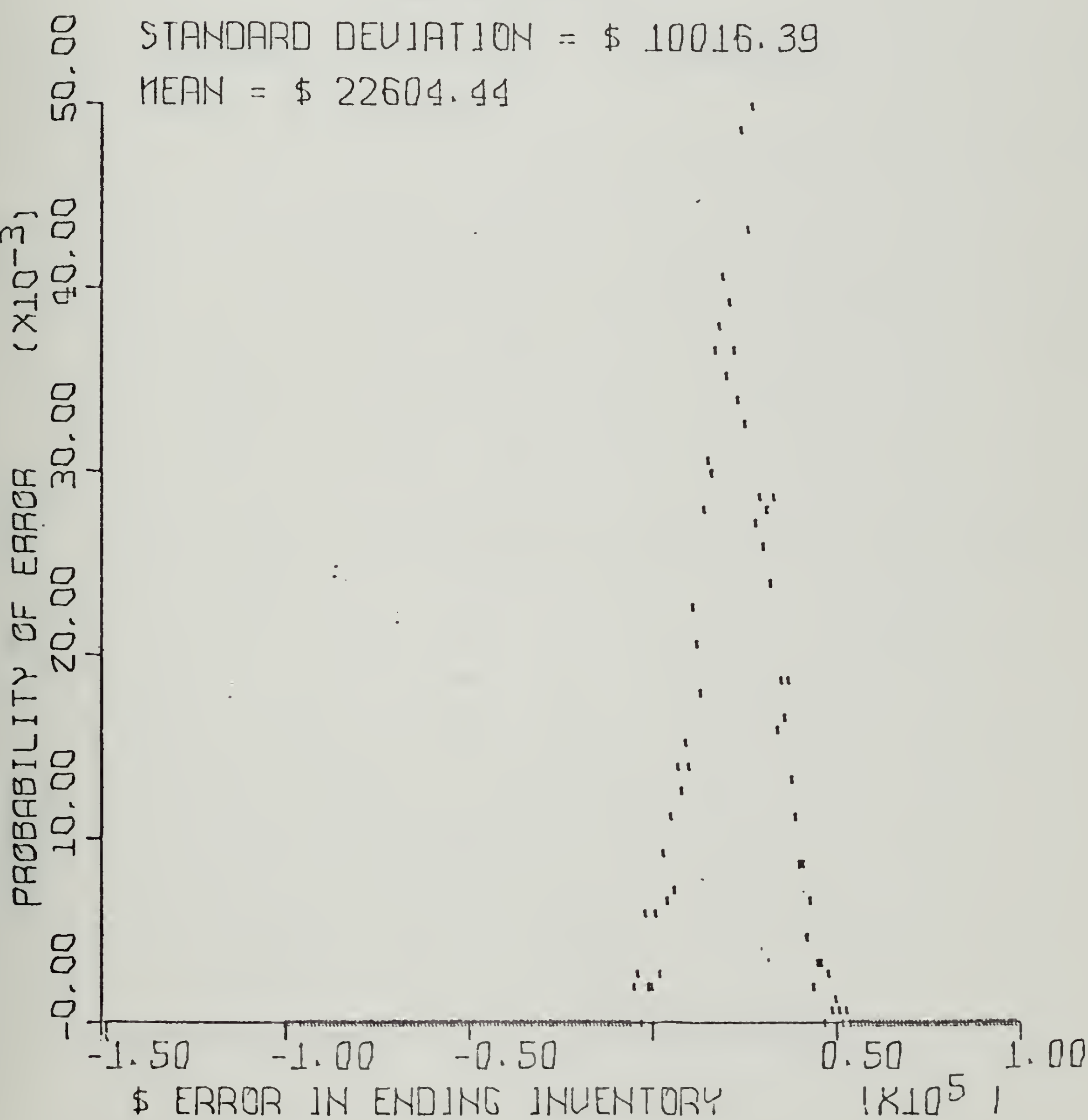


FIGURE C-3D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM

* * * * * * *

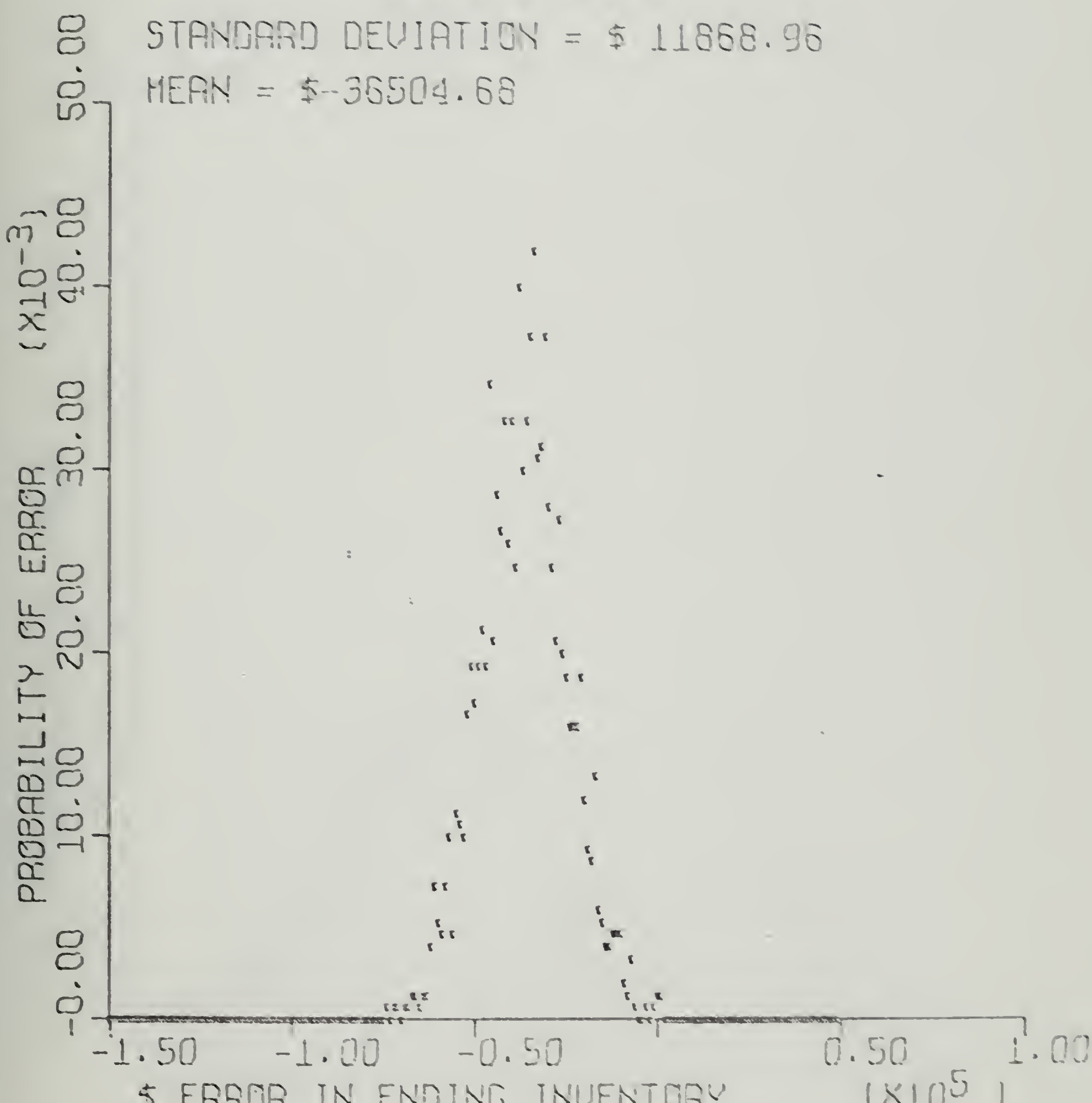


FIGURE C-4A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 23354.54
MEAN = $-62486.86

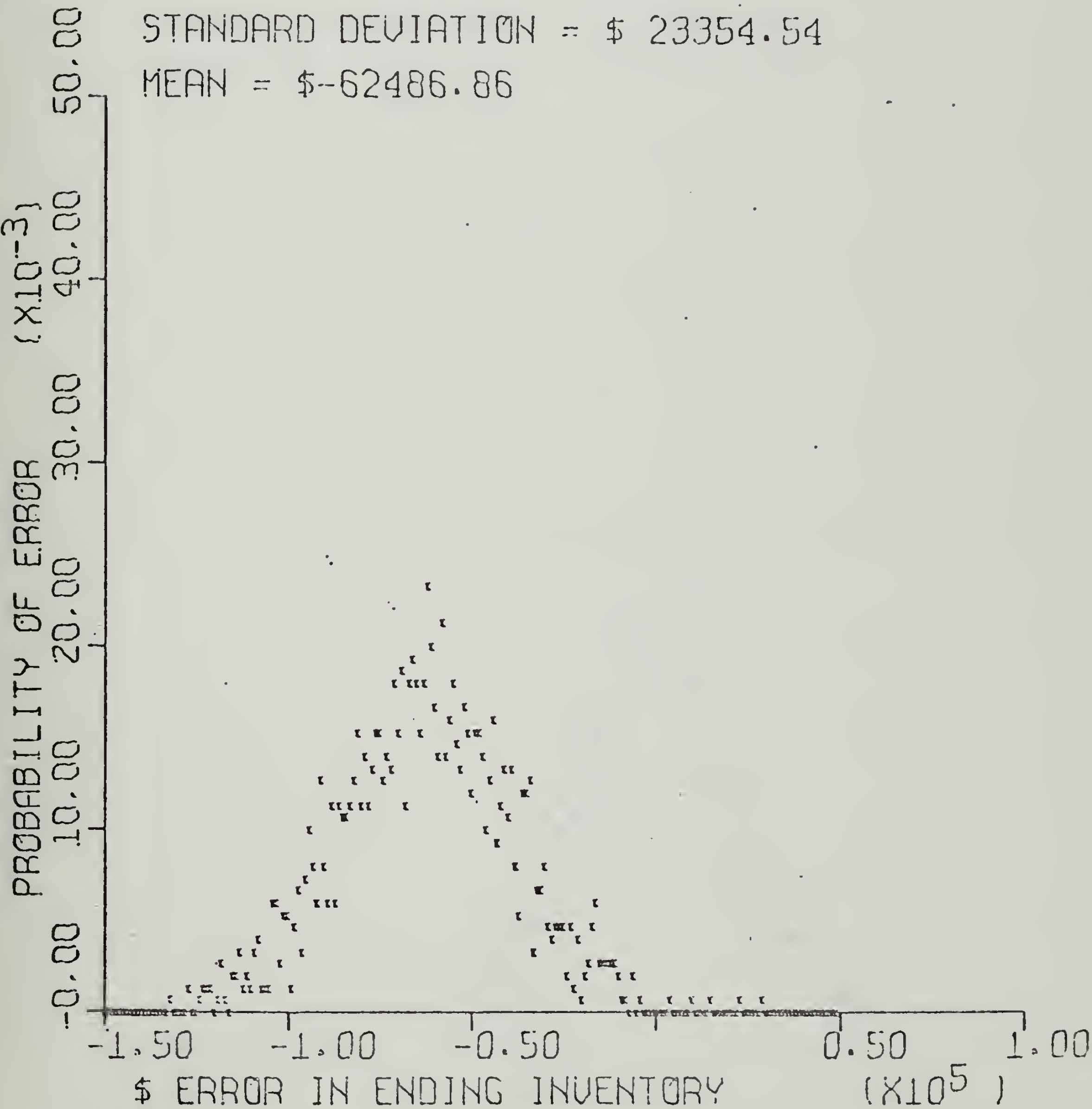


FIGURE C-4B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 20960.86
MEAN = $ 1505.26

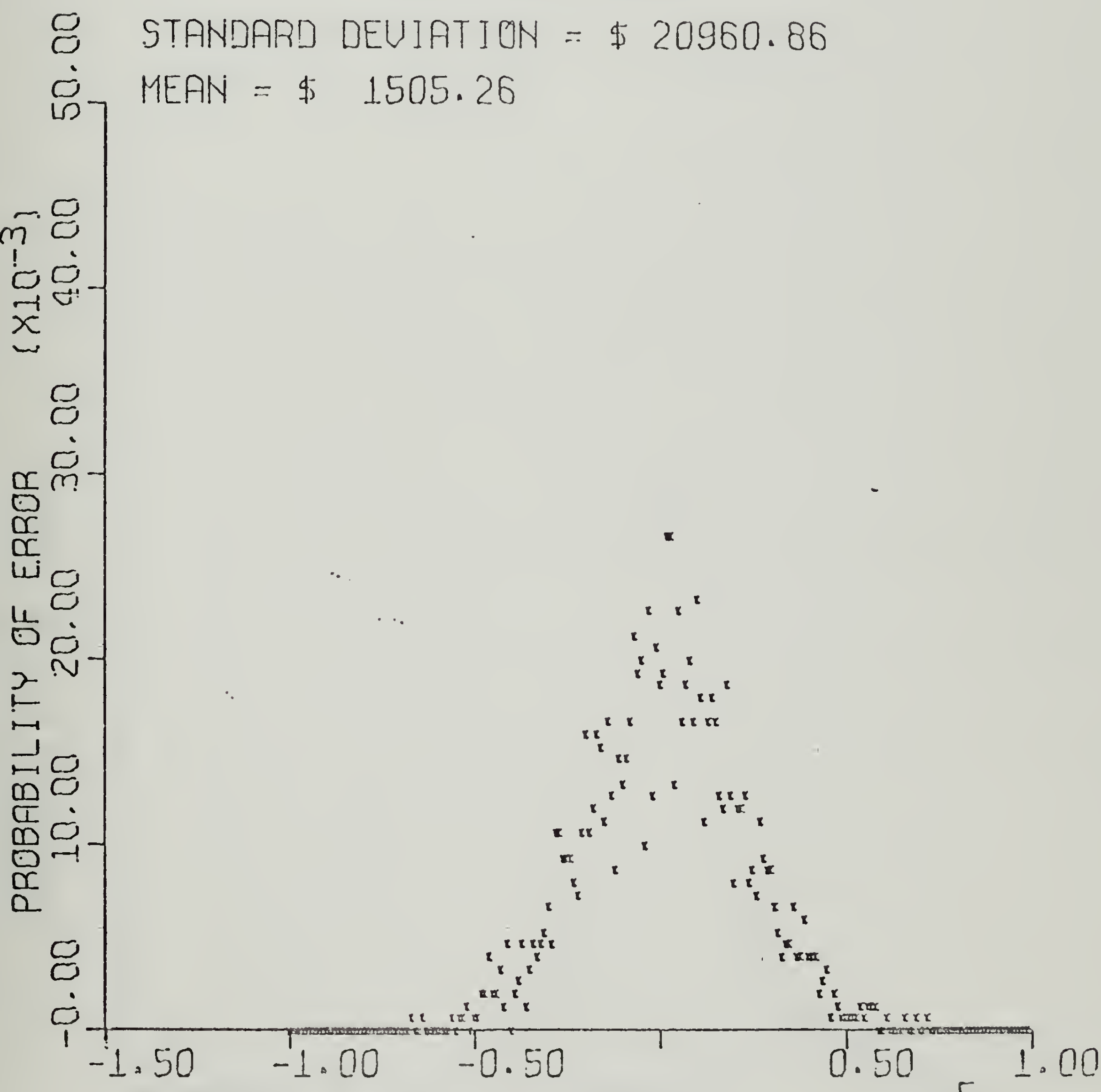


FIGURE C-4C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 13693.77
MEAN = $ -1204.72

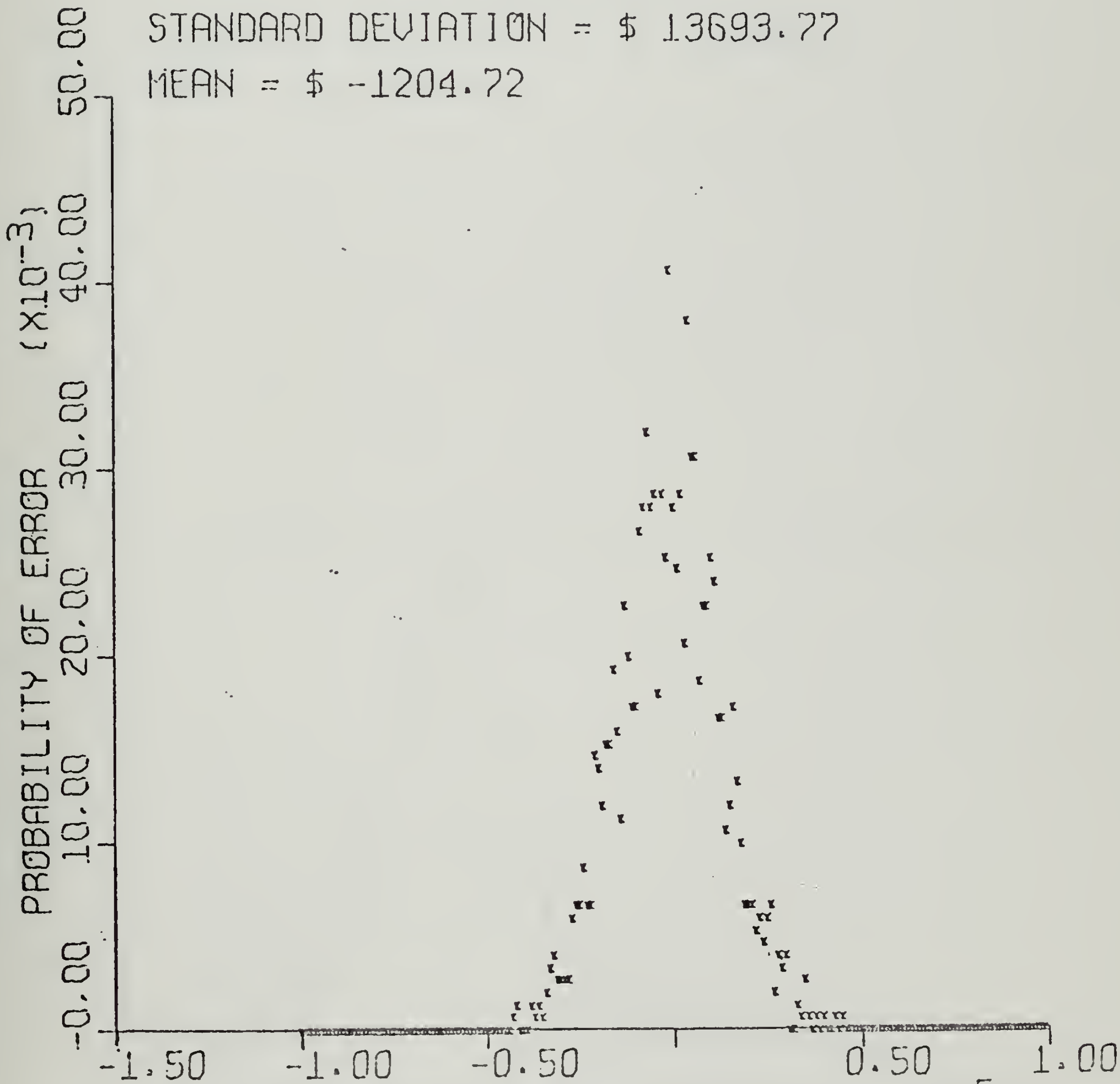


FIGURE C-4D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 17765.88
MEAN = $-61208.64

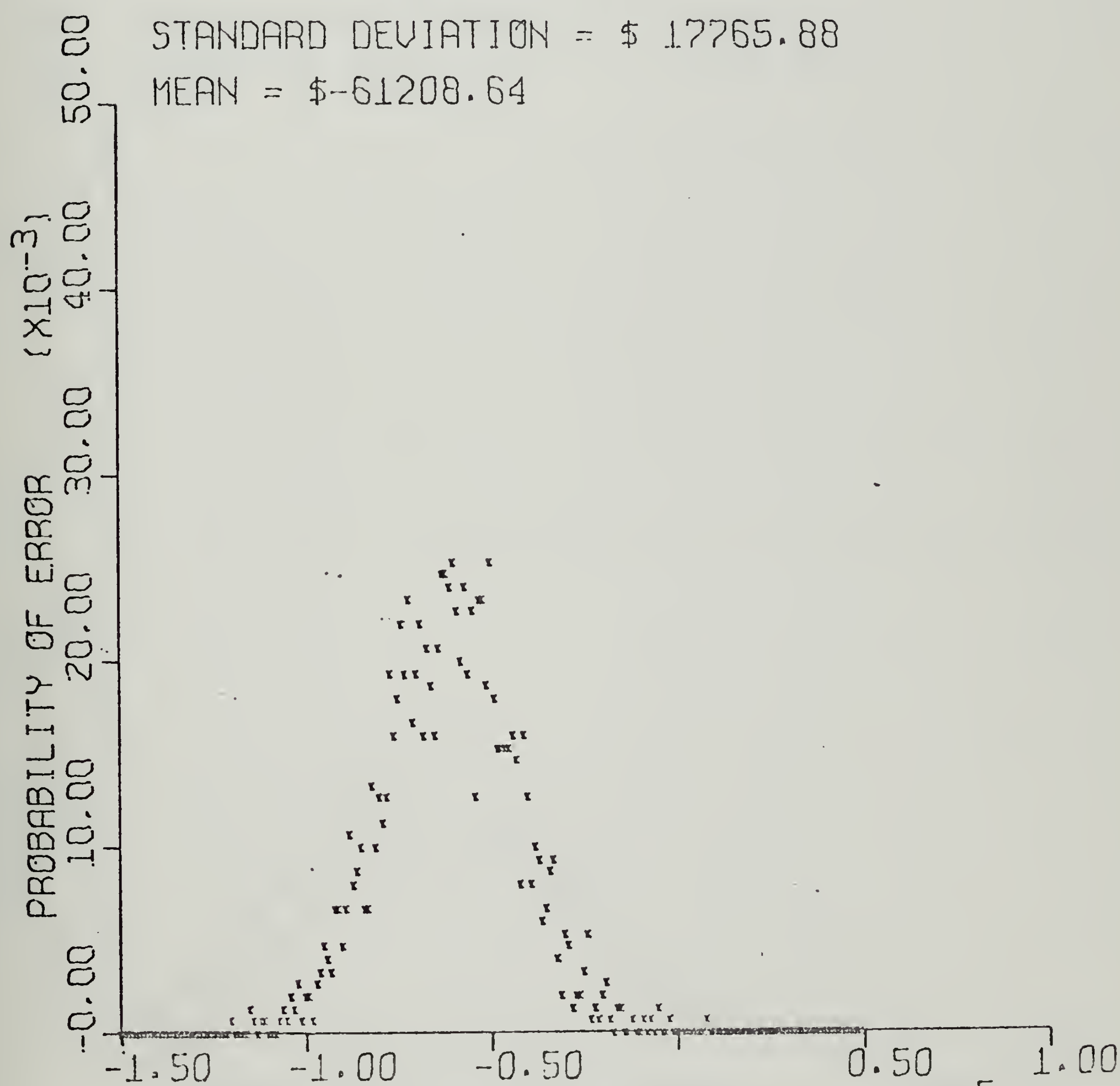


FIGURE C-5A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 31998.41
MEAN = $-61541.91

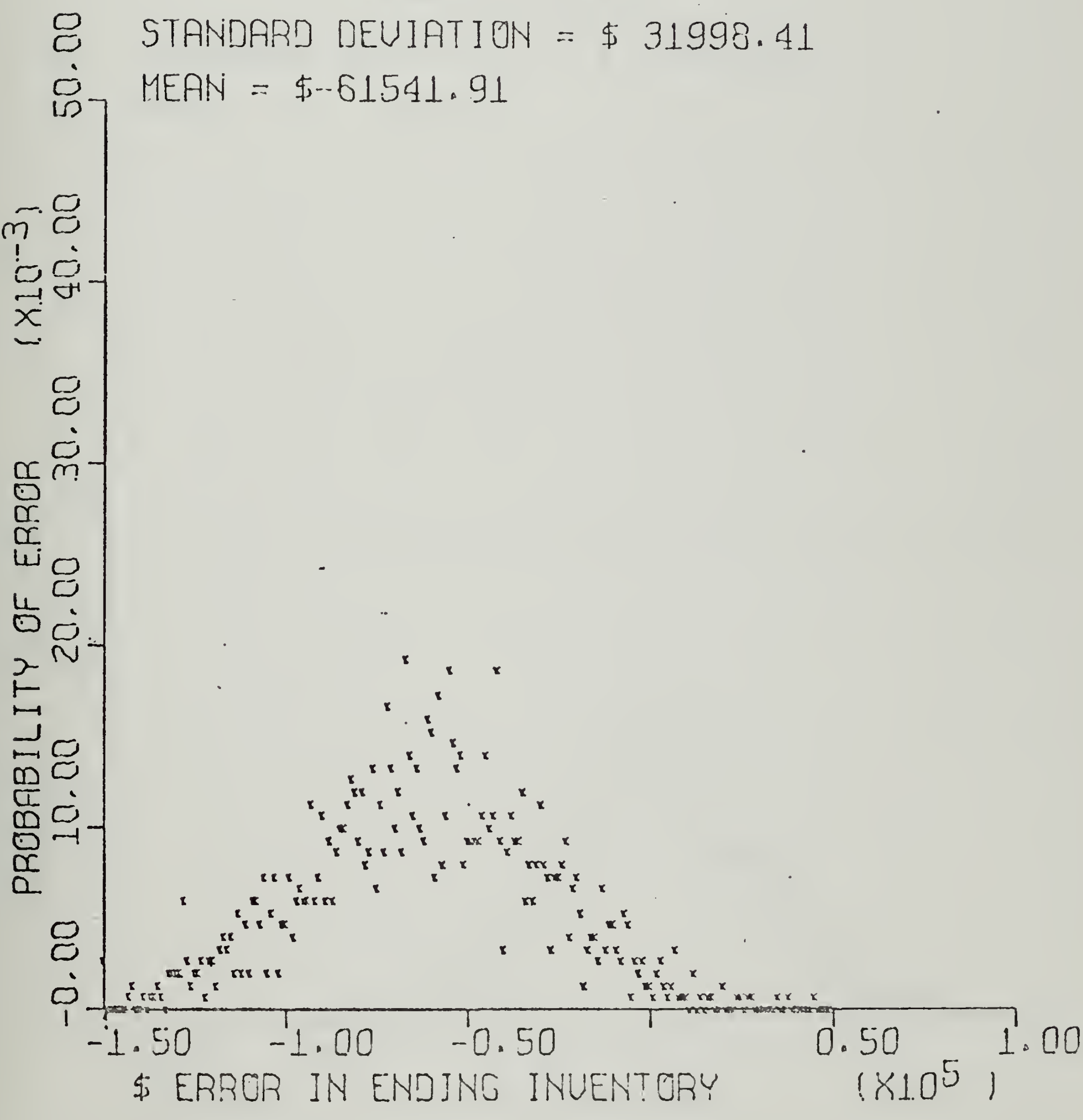


FIGURE G-5B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 27093.21
MEAN = $ 130.57

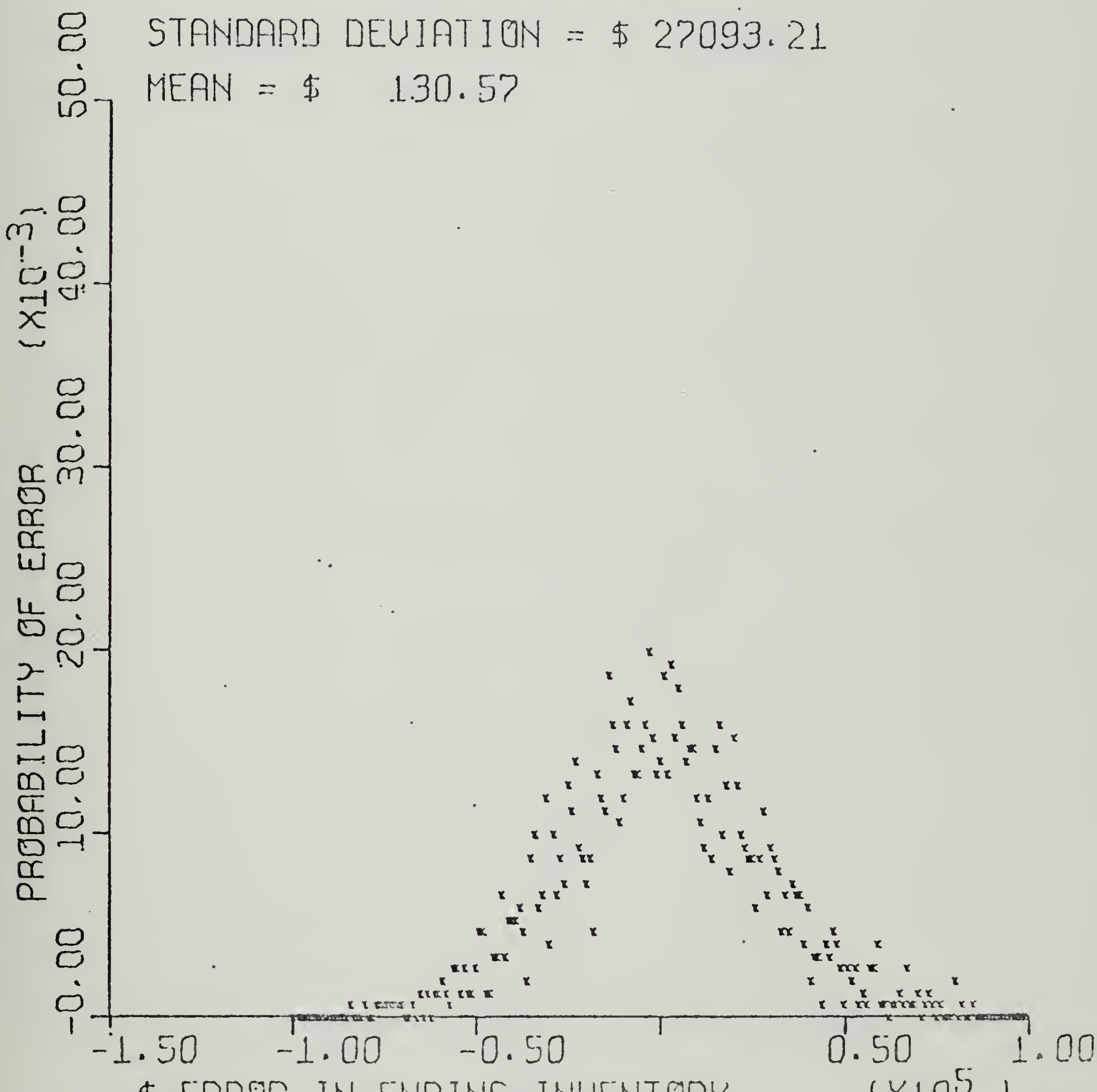


FIGURE C-5C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 17195.67
MEAN = $ -876.33

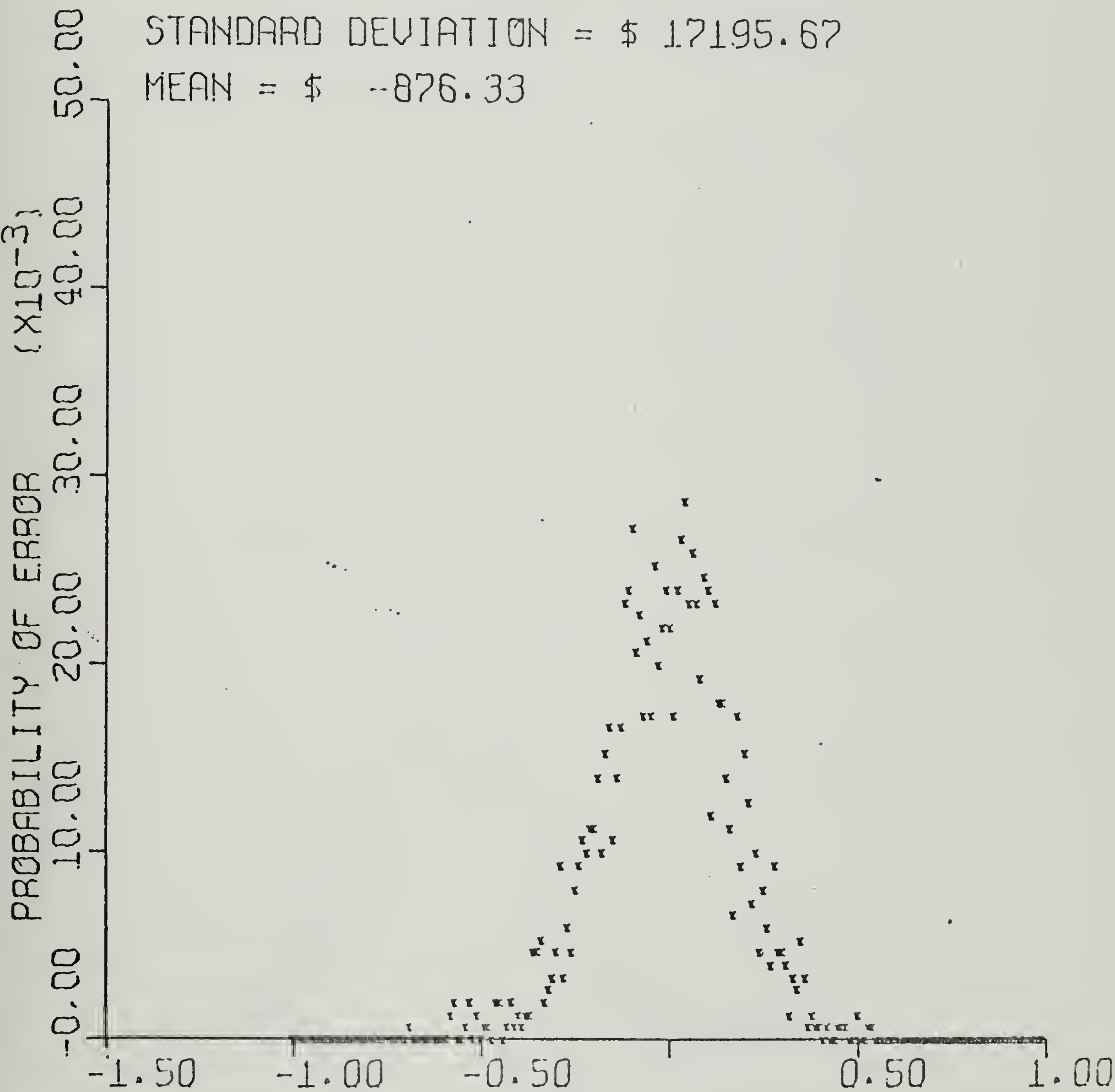


FIGURE C-5D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION EXPONENTIAL
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 24446.31
MEAN = $-61343.90

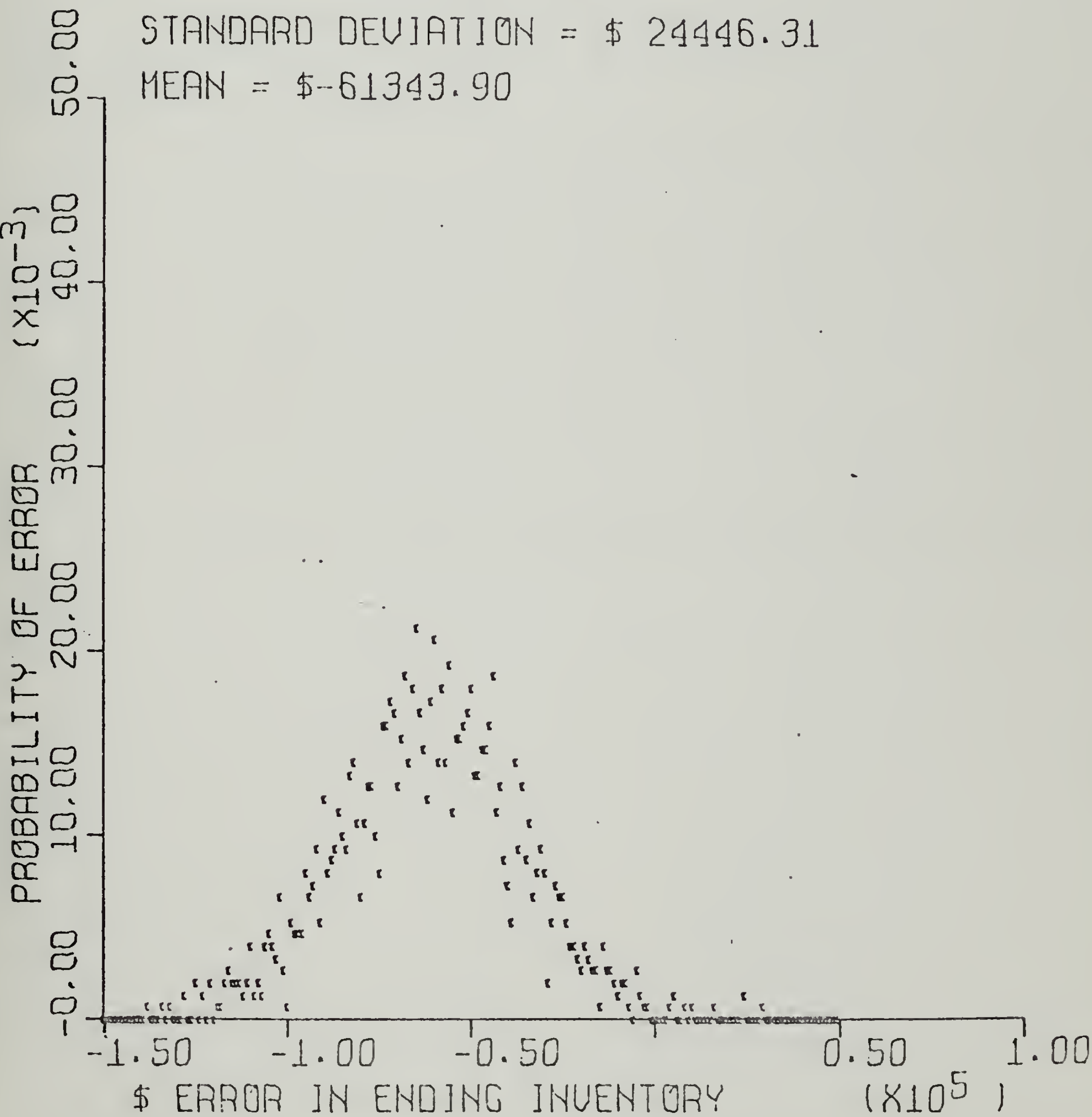


FIGURE C-6A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = \$ 23370.81
MEAN = \$-61915.95

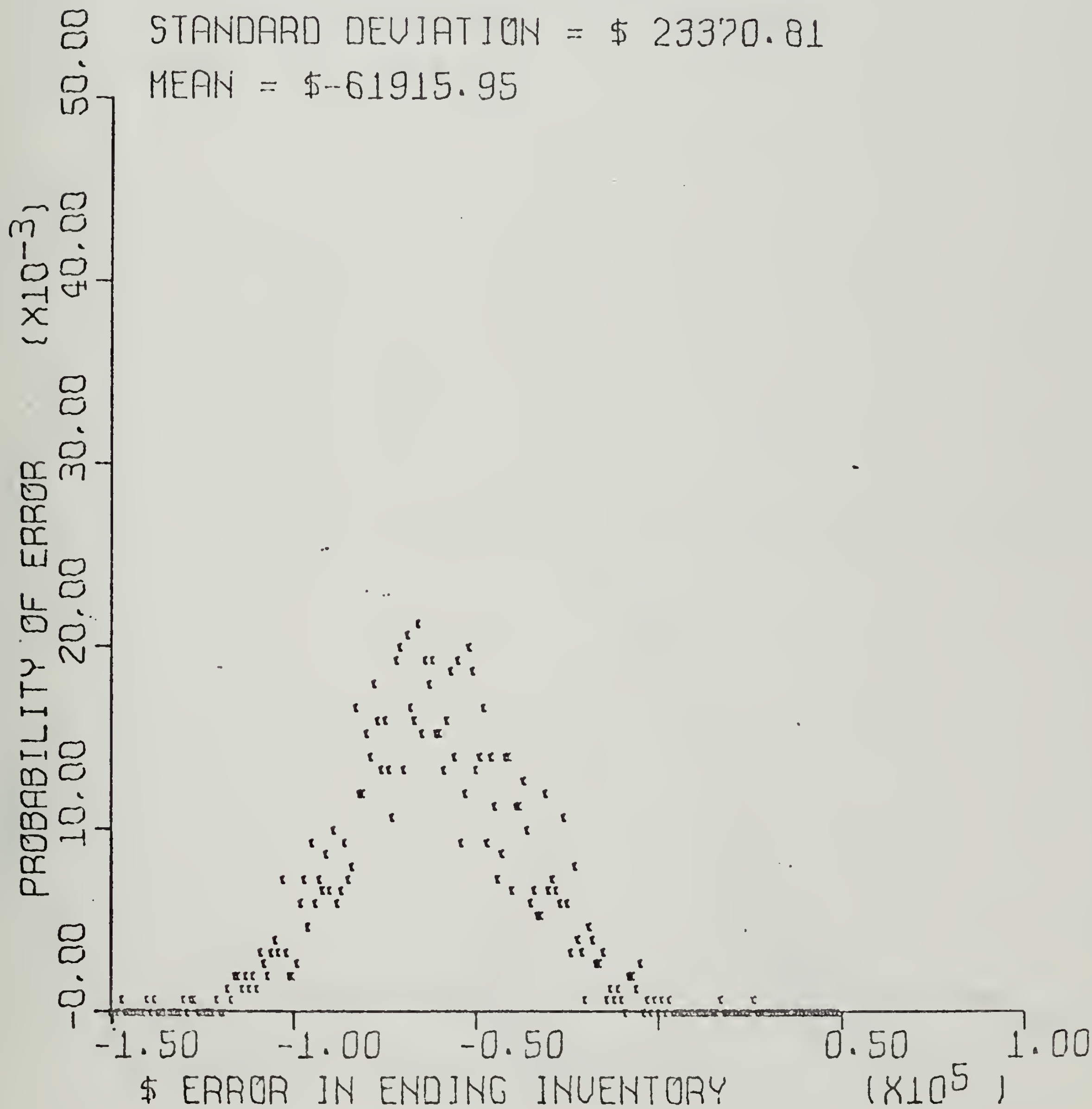


FIGURE C-6B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 19792.98
MEAN = $ 1114.32

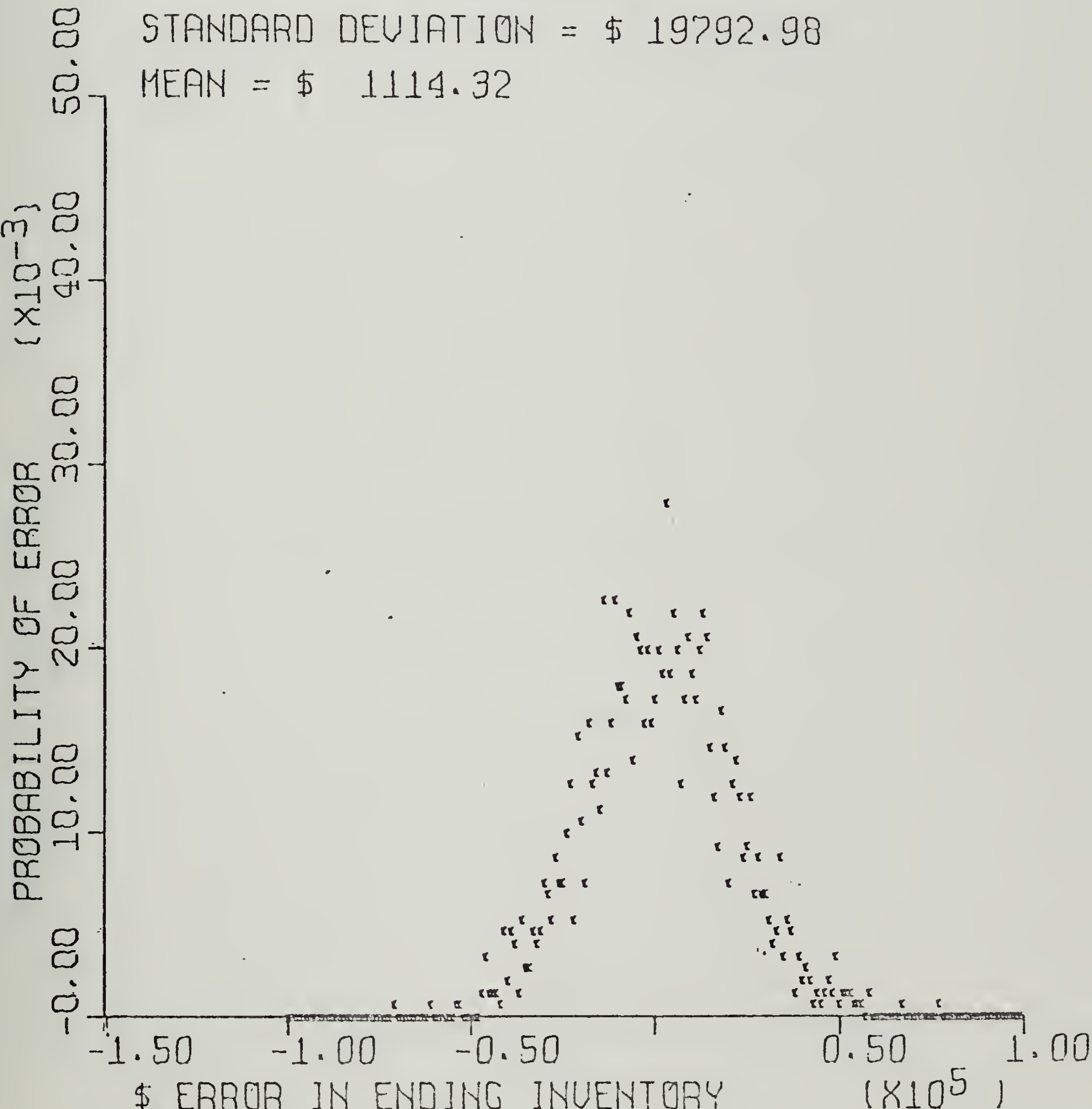


FIGURE C-6C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = \$ 13217.66
MEAN = \$ -2398.77

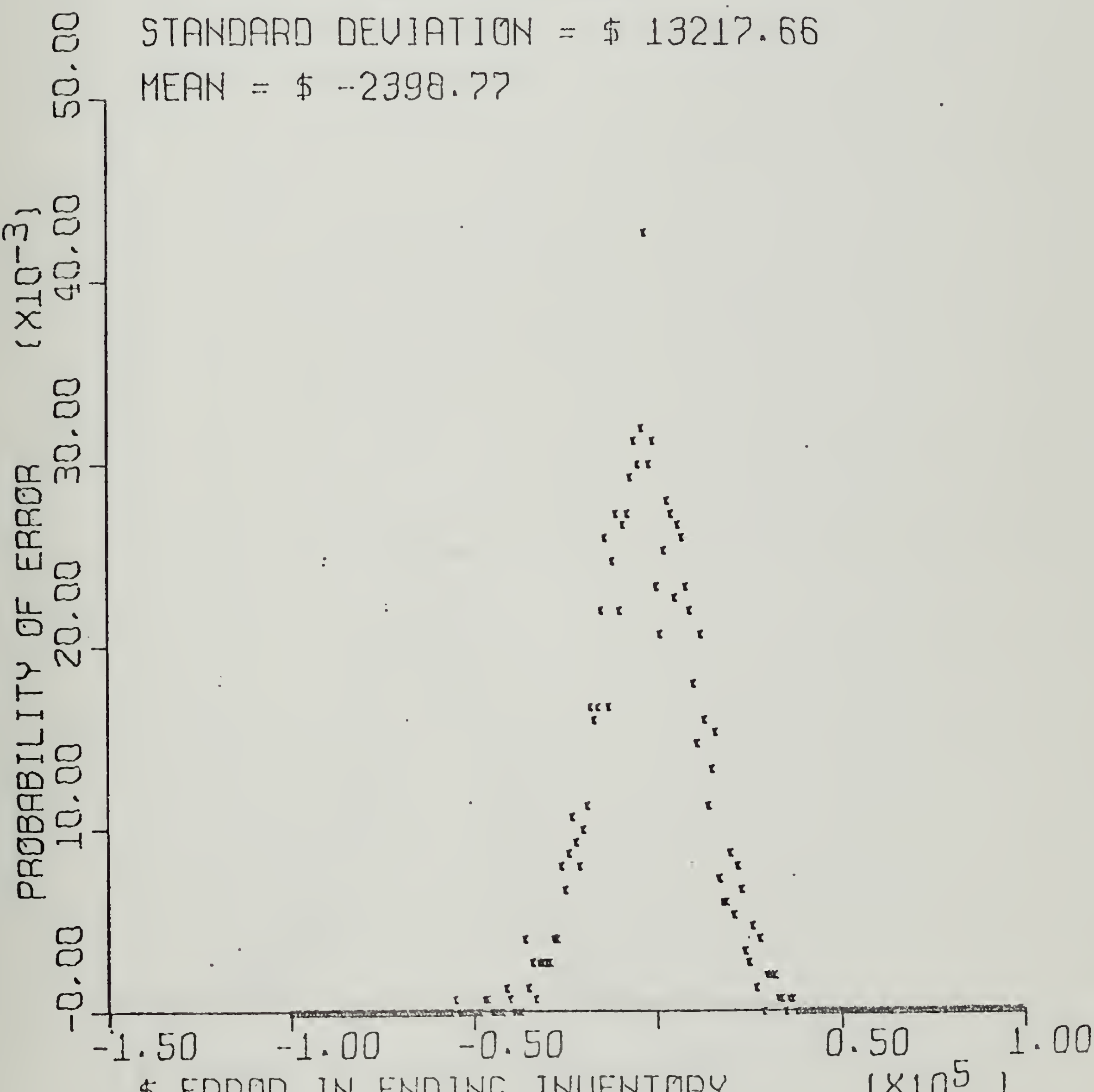


FIGURE C-6D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION UNIFORM
WITH DOUBLED MEAN

* * * * * * *

STANDARD DEVIATION = $ 17456.34
MEAN = $-62193.40

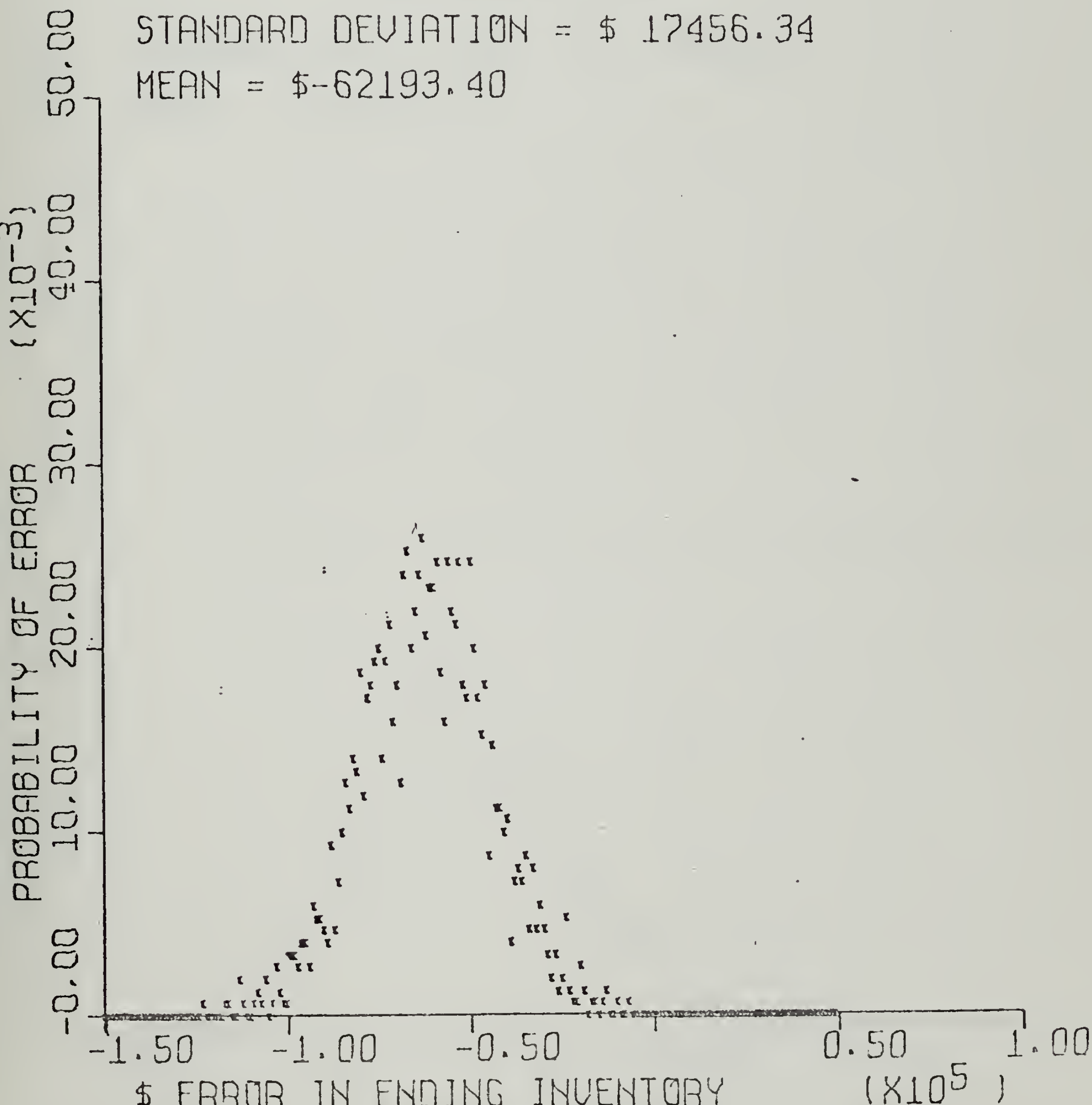


FIGURE C-7A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 18 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 22146.1
MEAN = $-121603.9

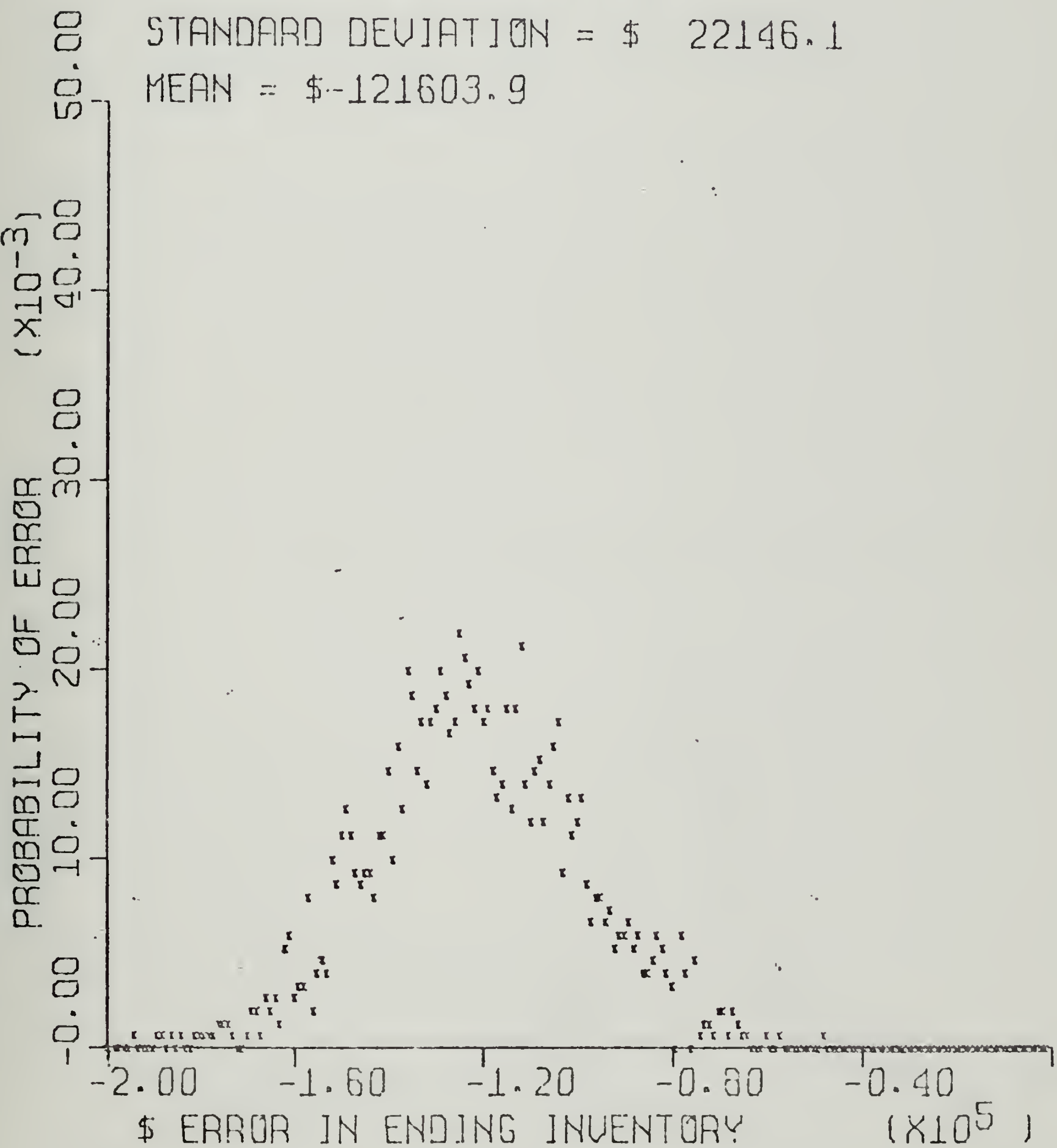


FIGURE C-7B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 18 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 20353.00
MEAN = $ 1072.38

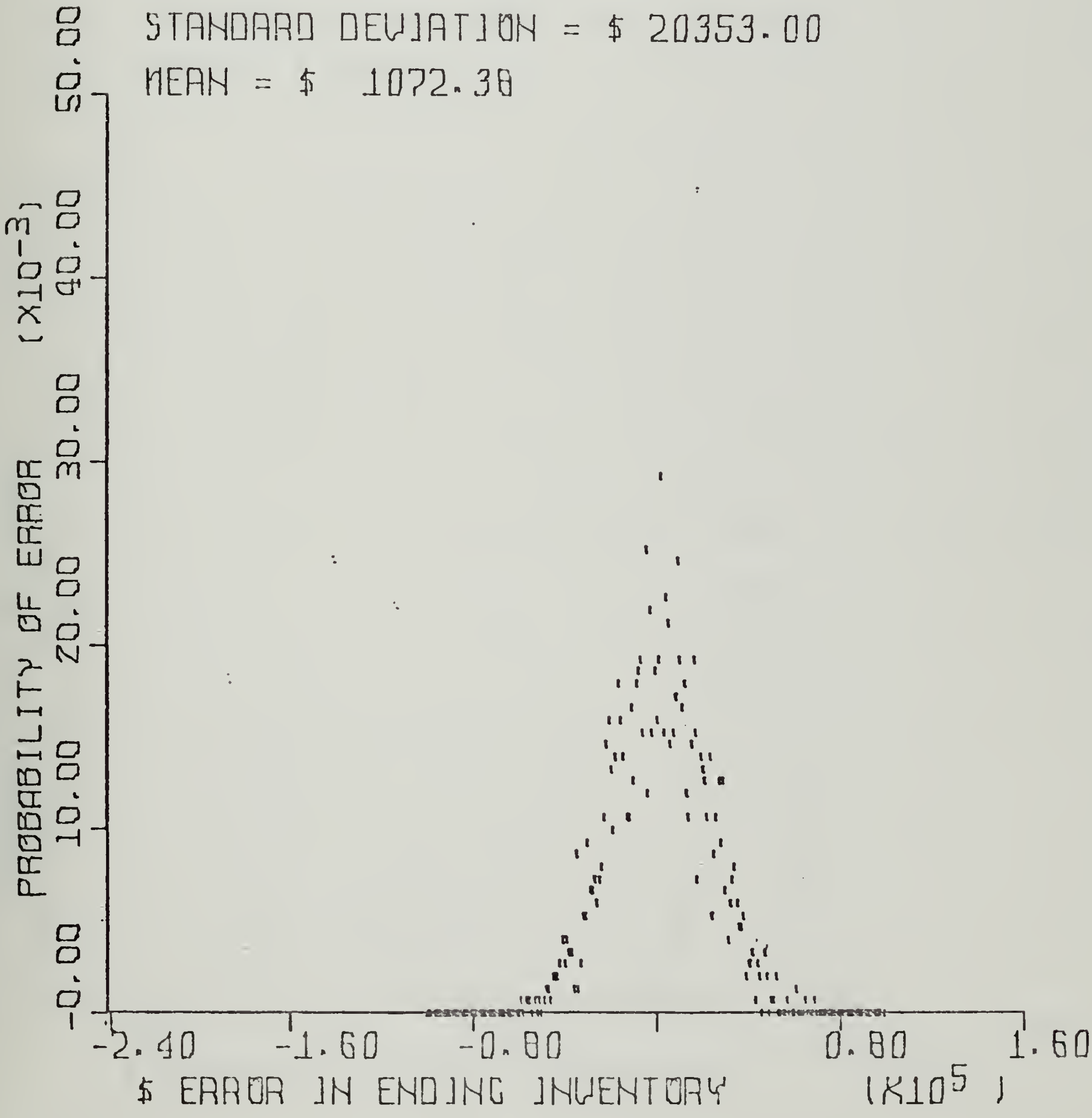


FIGURE C-7C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 18 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 14594.46
MEAN = $ 42870.77

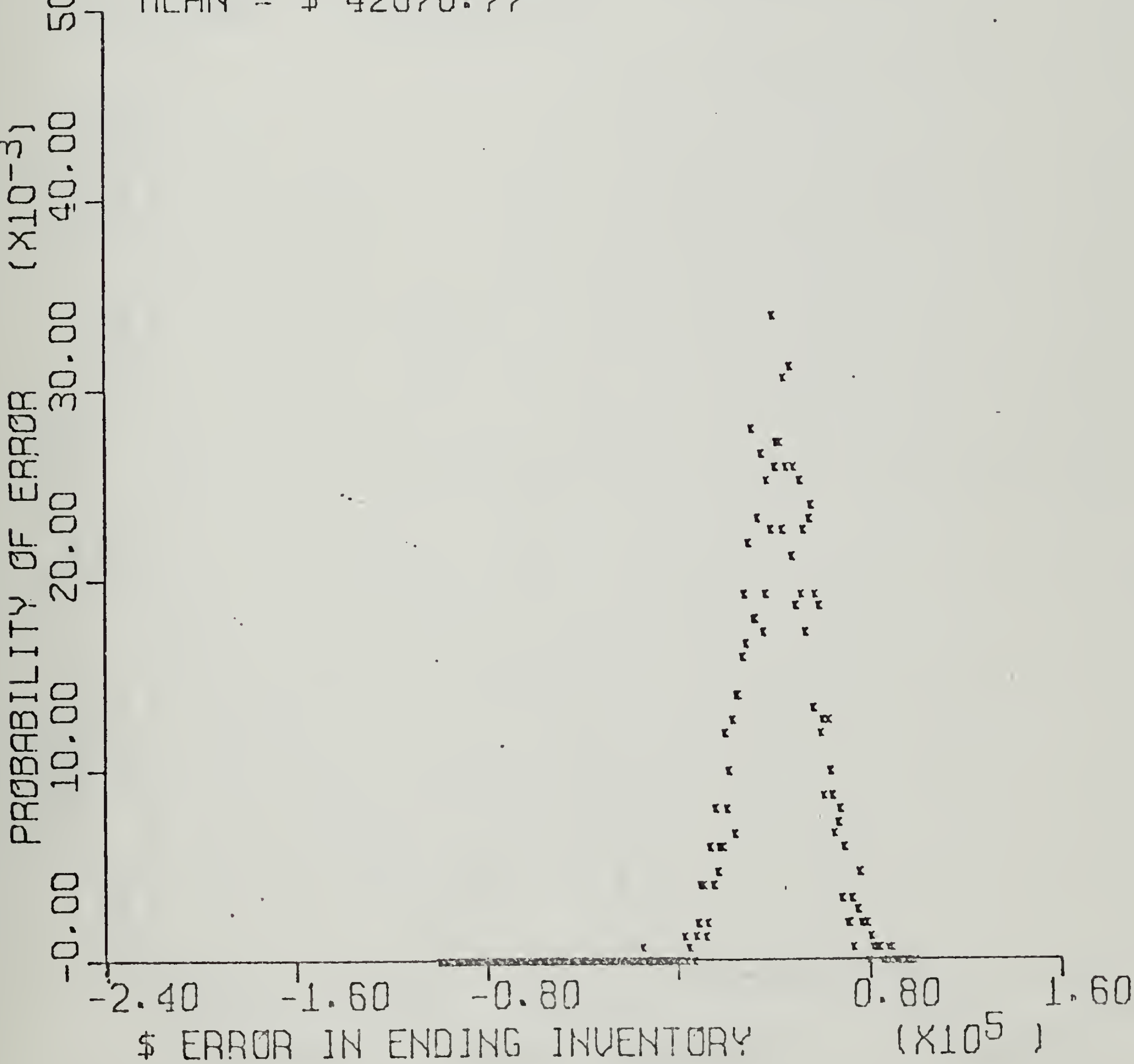


FIGURE C-70

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 18 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 17066.17
MEAN = $-76653.38

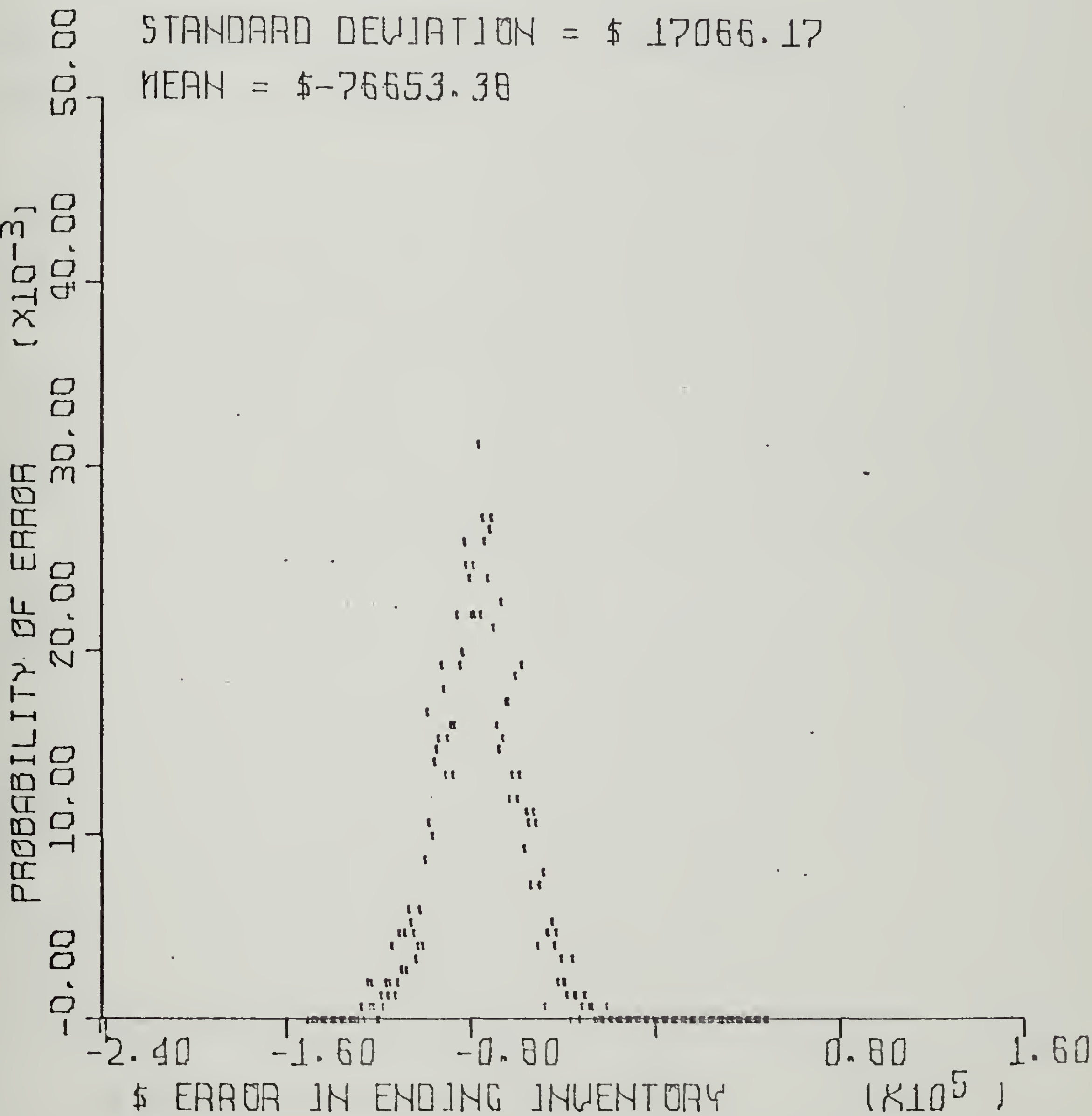


FIGURE C-8A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 4.5 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 11665.26
MEAN = $-31056.97

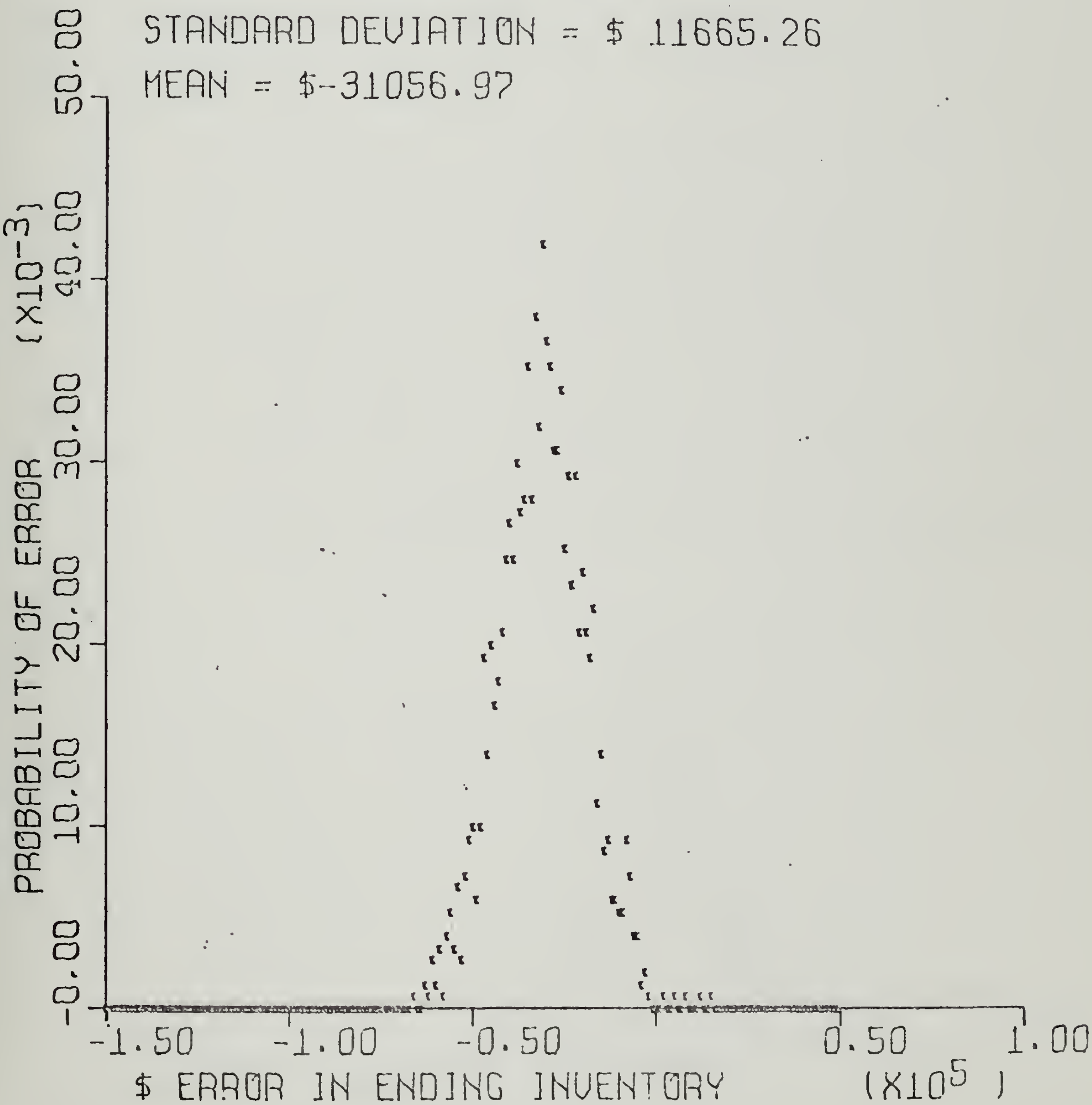


FIGURE C-8B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 4.5 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 10481.11
MEAN = $ 550.71

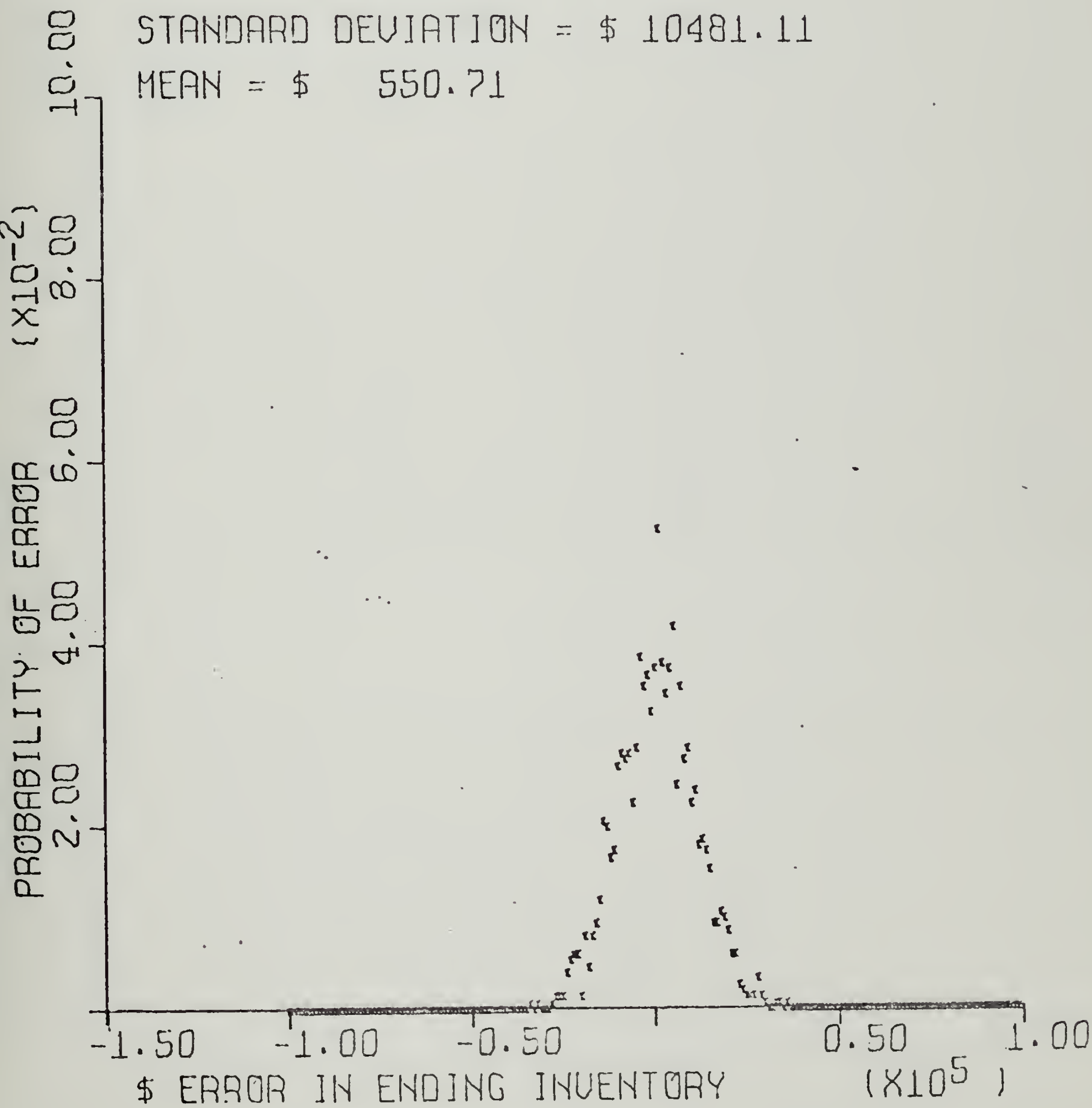


FIGURE C-8C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 4.5 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 7070.72
MEAN = $ 10007.17

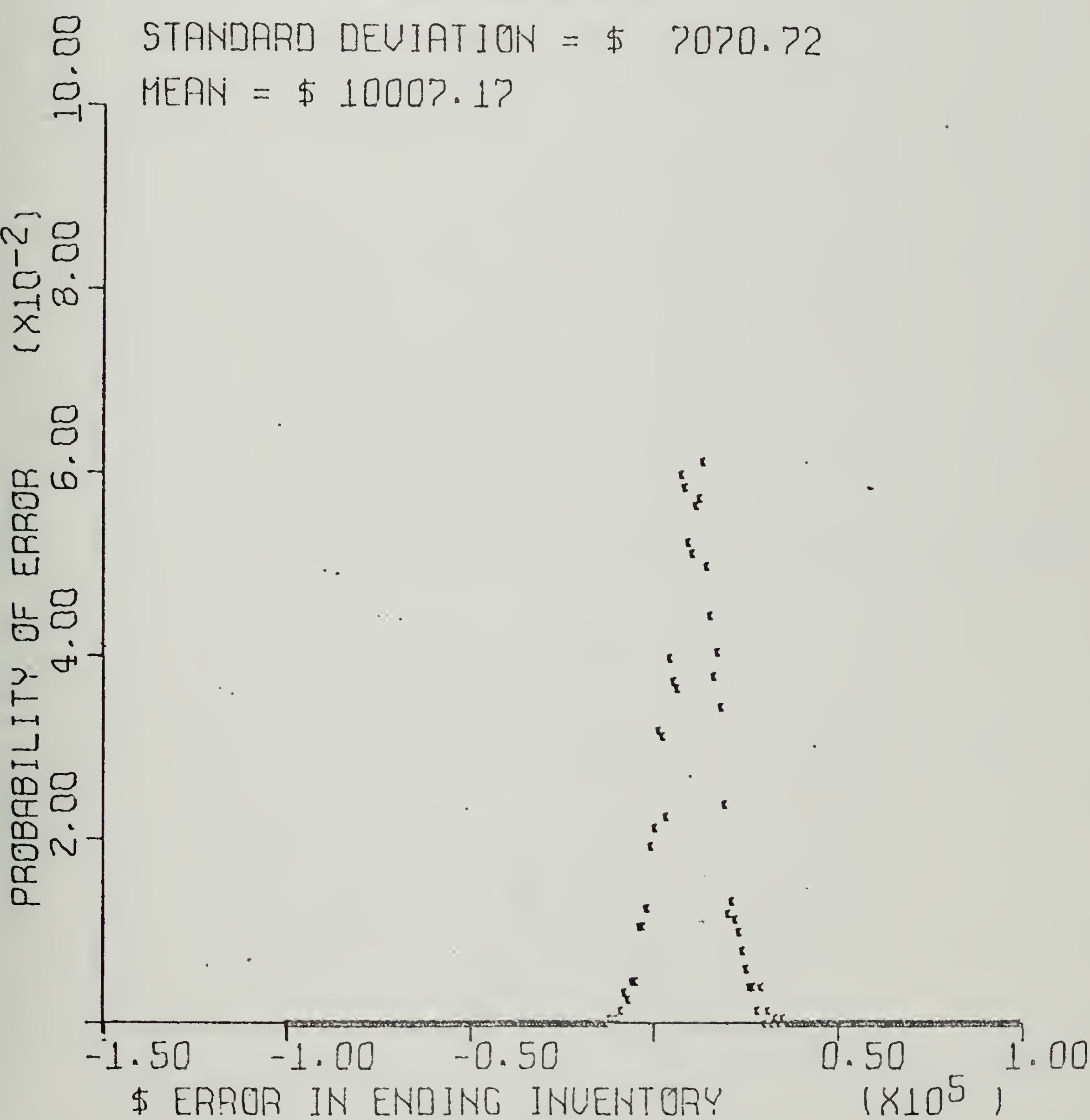


FIGURE C-8D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 4.5 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 8800.25
MEAN = $-19478.05

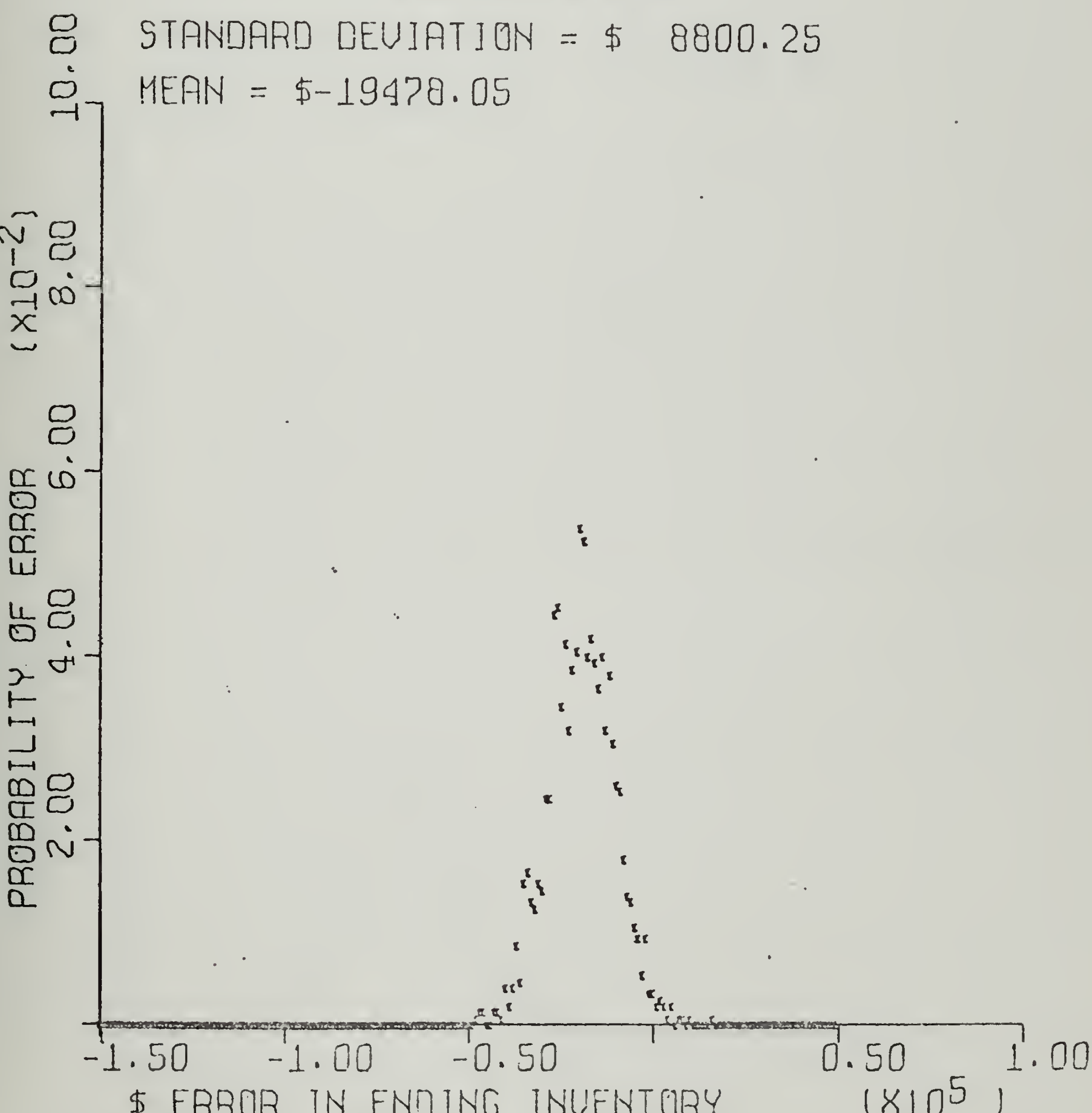


FIGURE C-9A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 15198.48
MEAN = $-70440.38

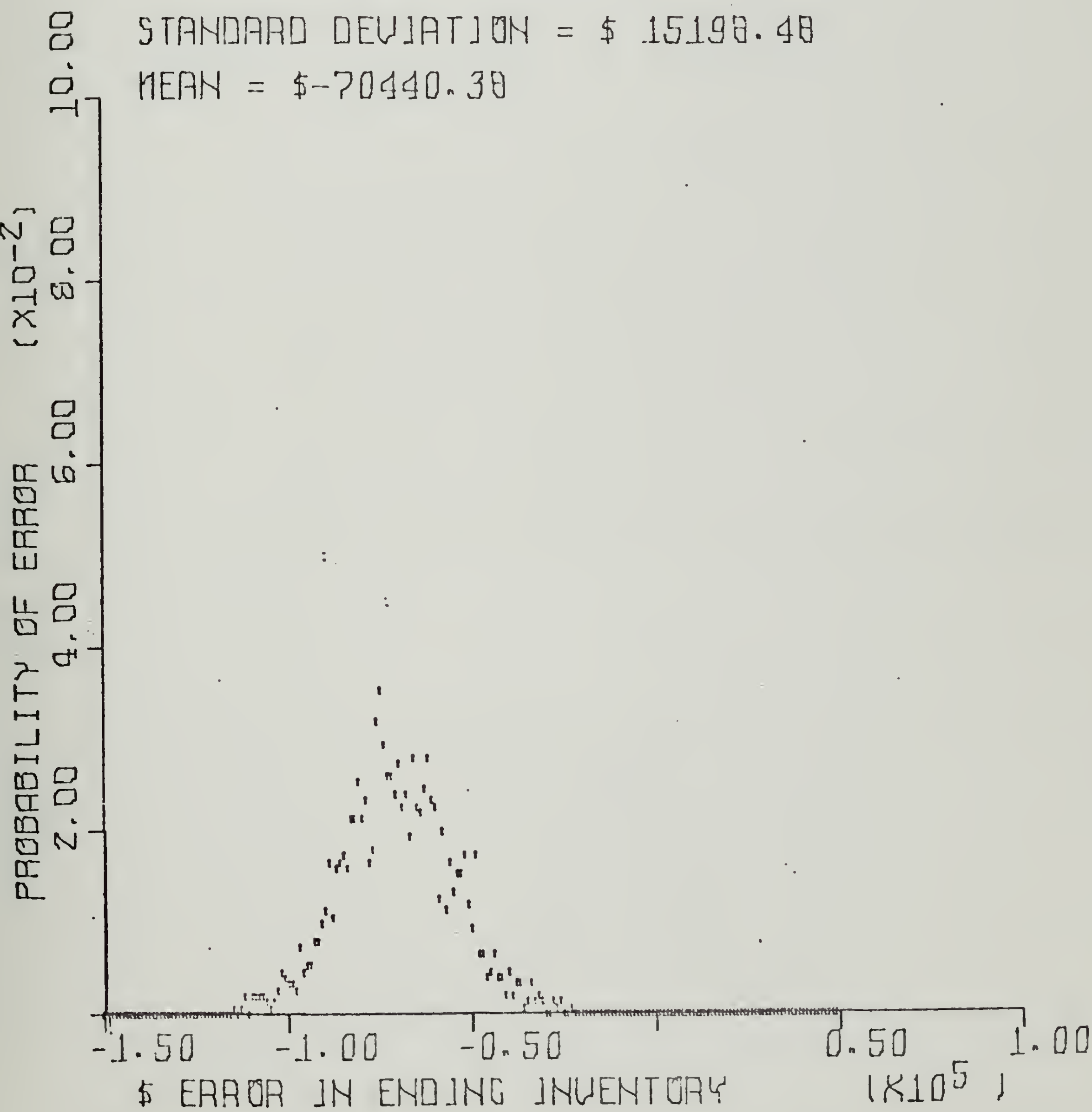


FIGURE C-9B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 14438.03
MEAN = $ -8191.71

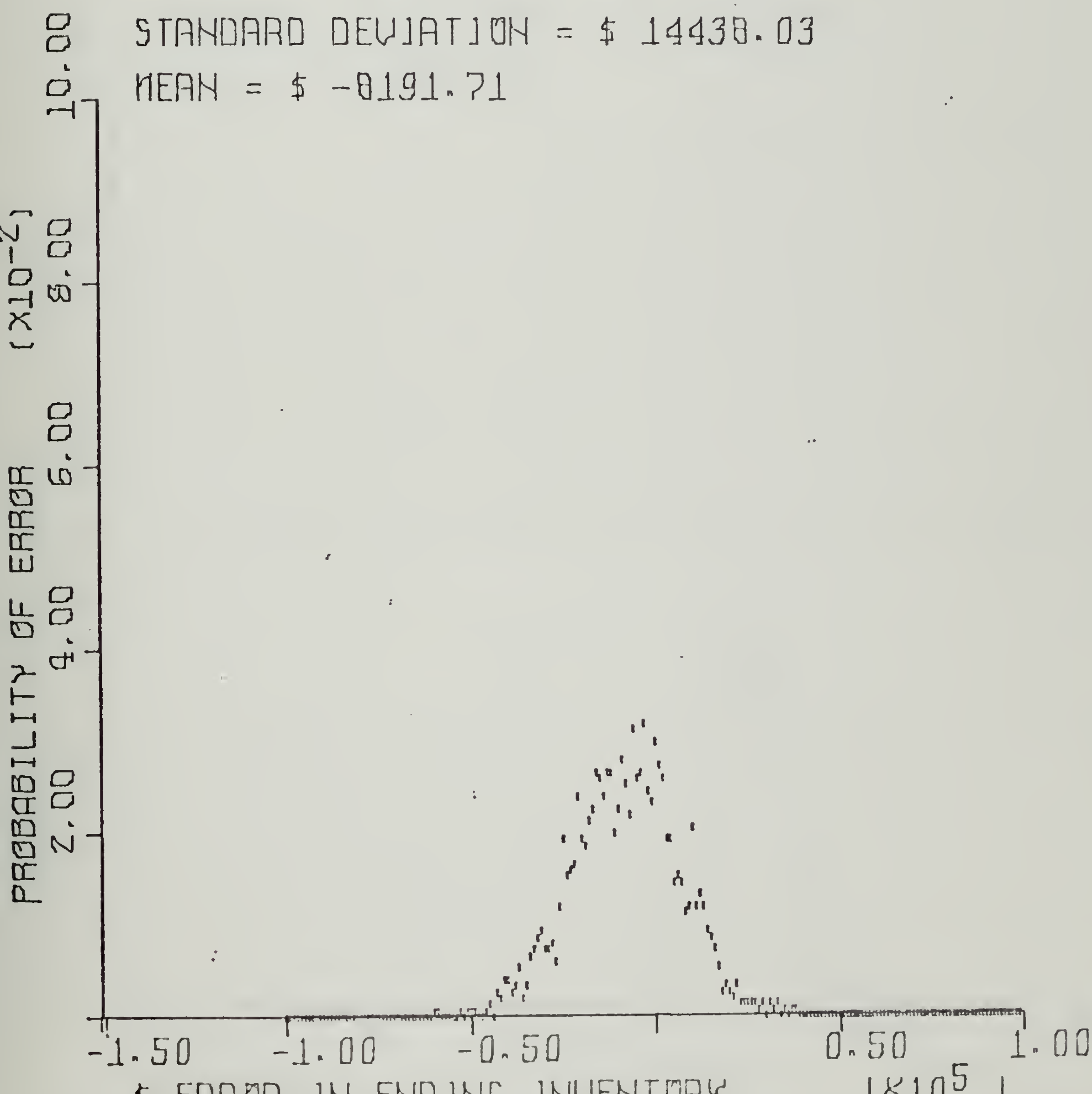


FIGURE C-9C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20688.29

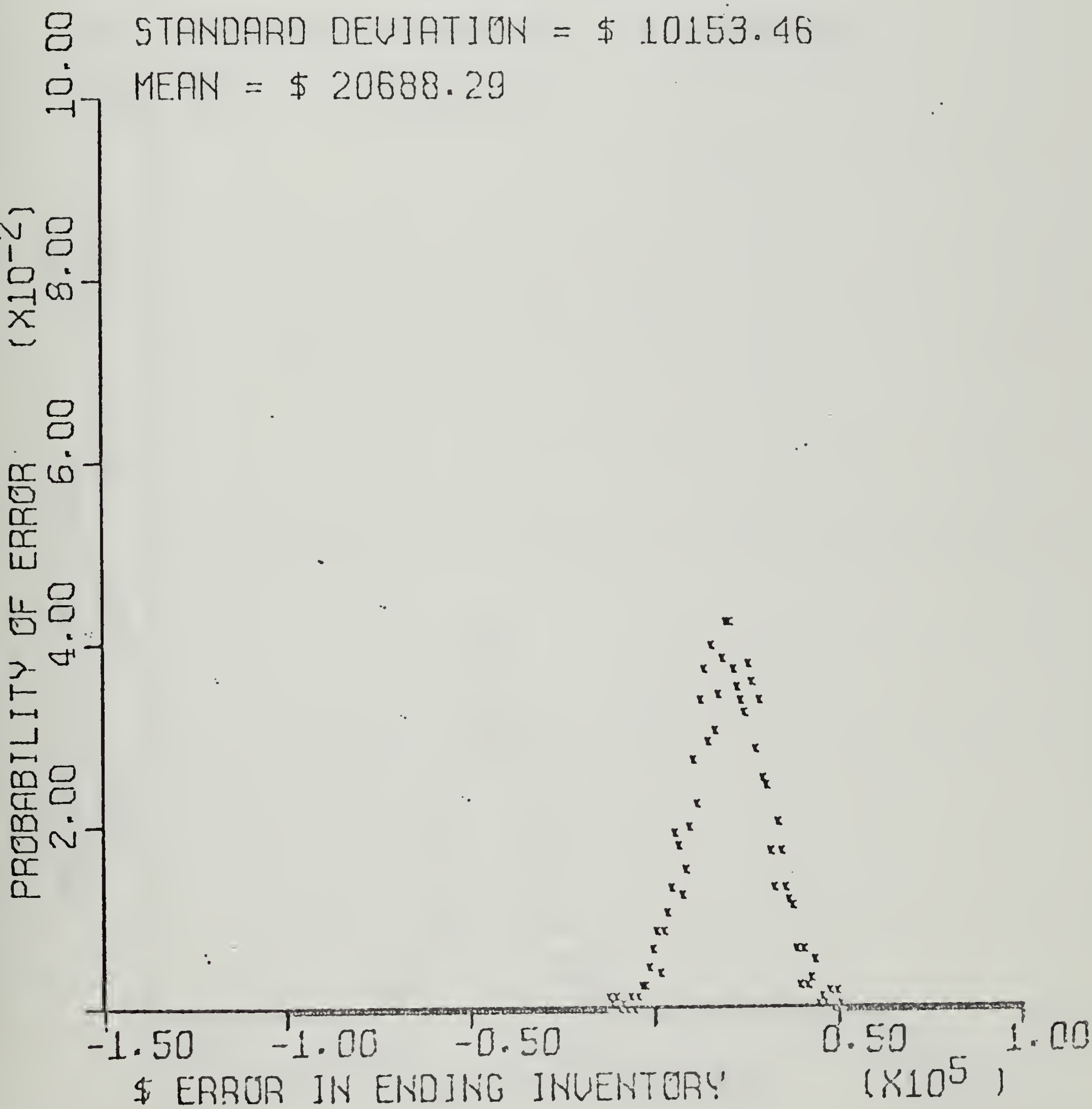


FIGURE C-9D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 11087.03
MEAN = $-56946.52

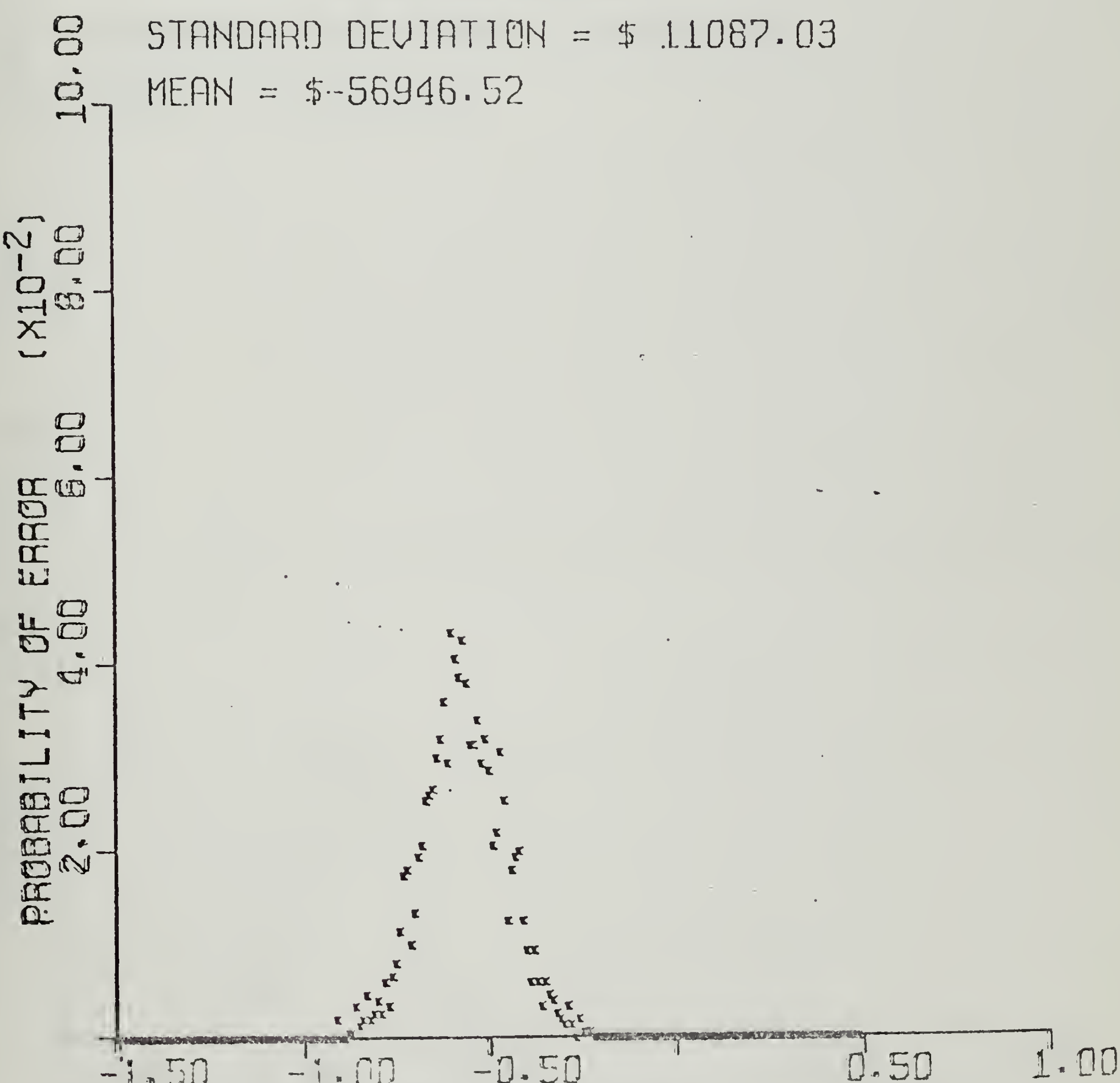


FIGURE C-10A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 12855.56
MEAN = $-73811.94

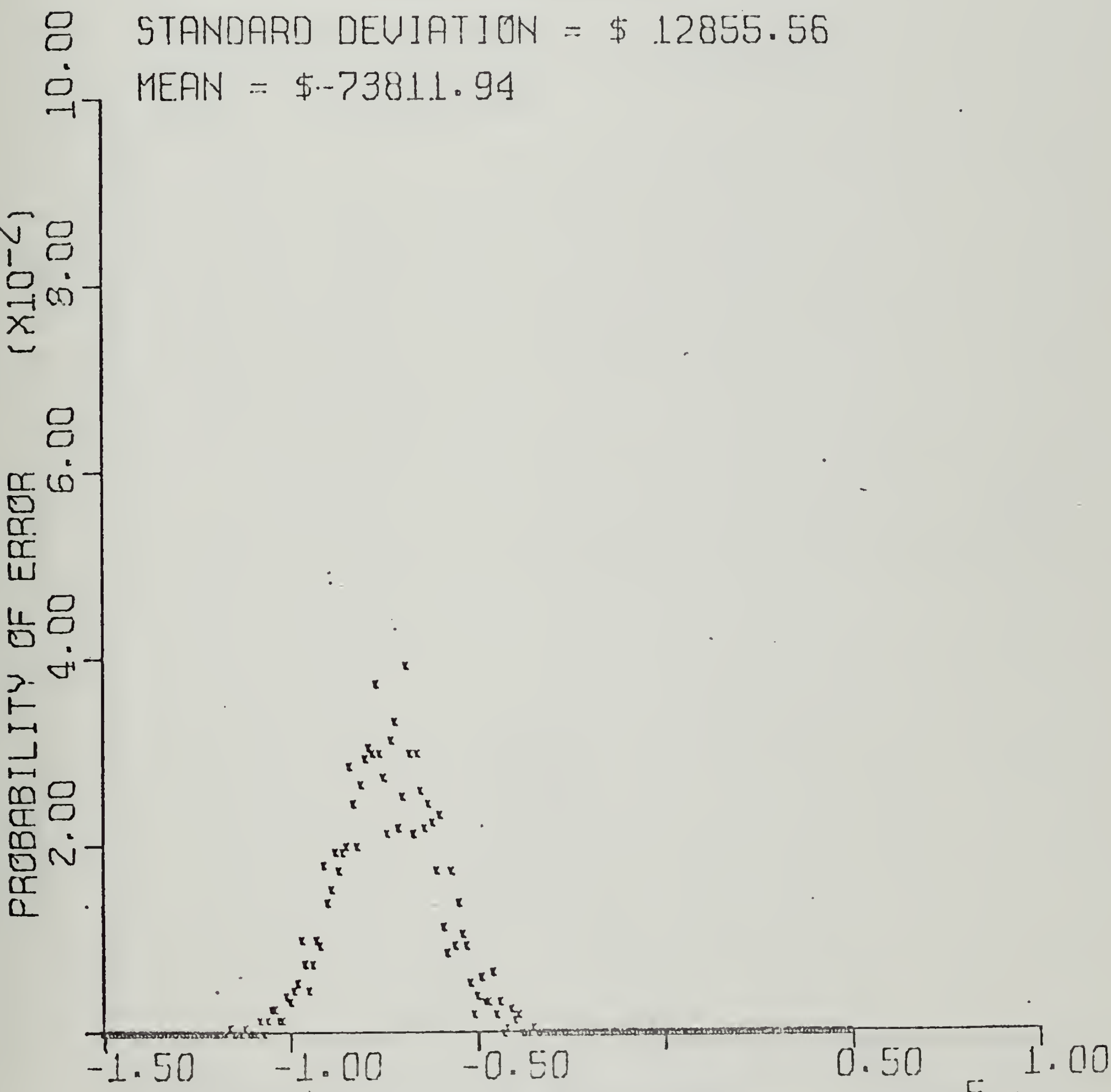


FIGURE C-10B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 13152.88
MEAN = $-35704.96

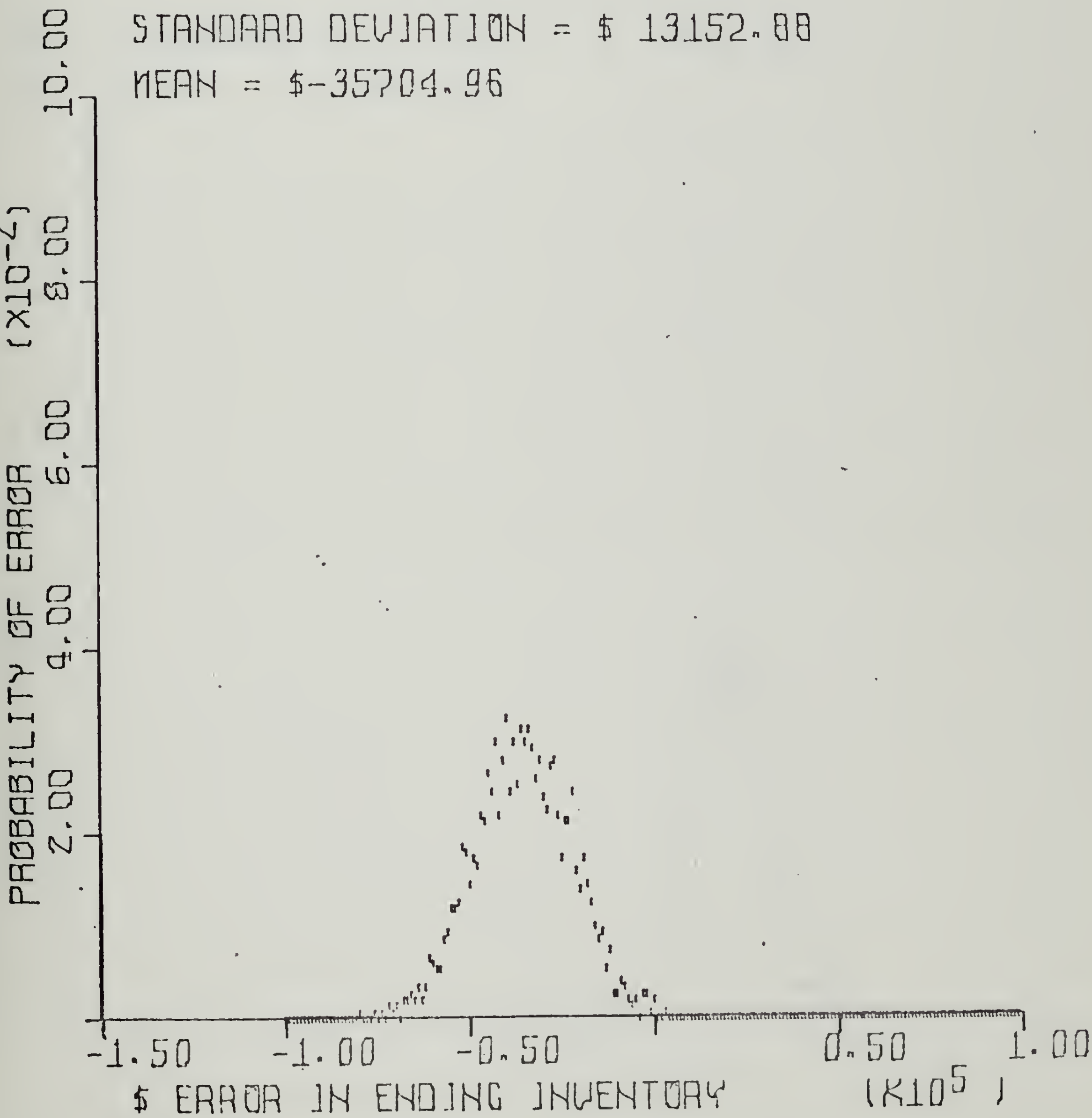


FIGURE C-10C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20688.29

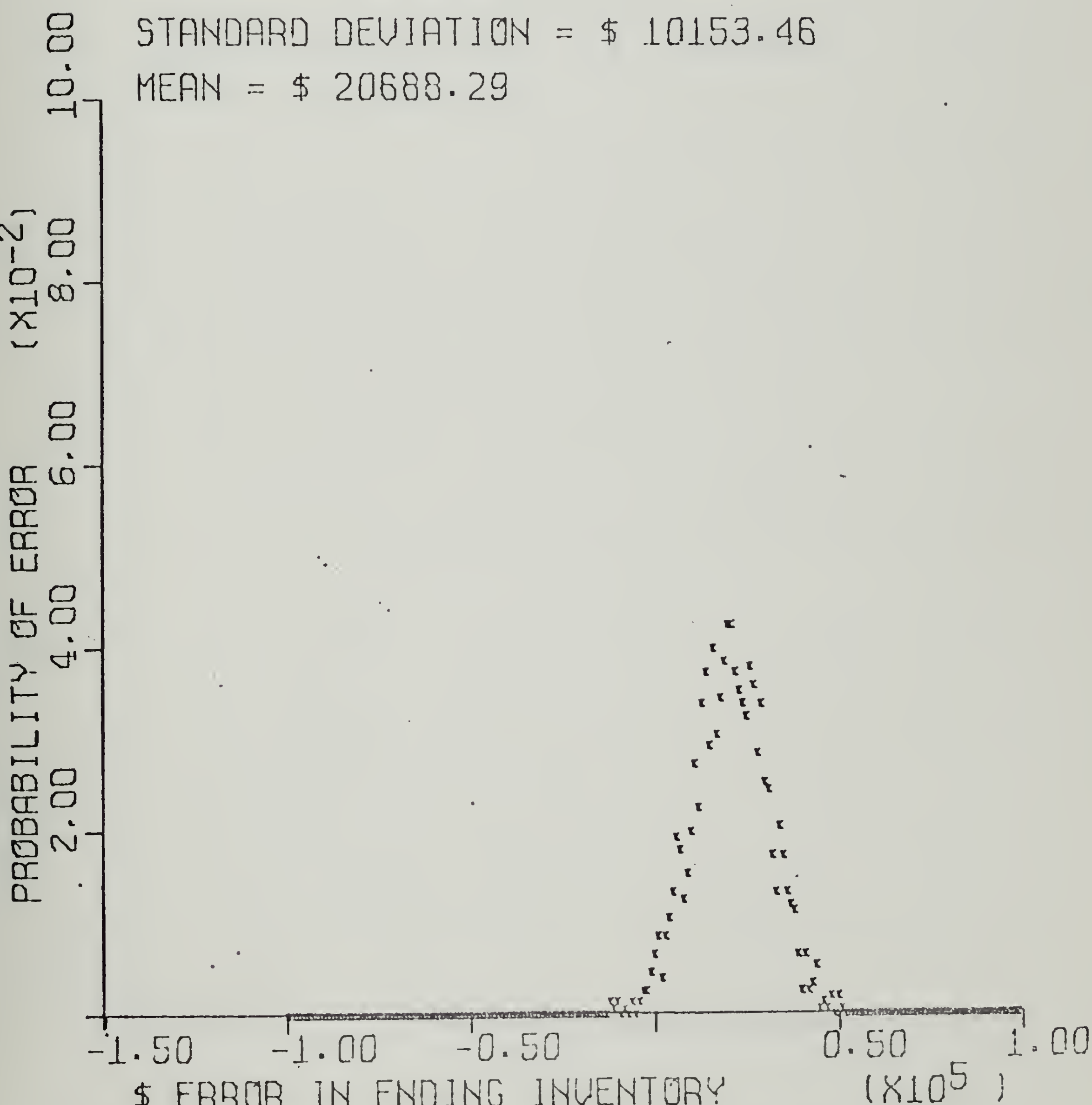


FIGURE C-10D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 9505.24
MEAN = $-87846.38

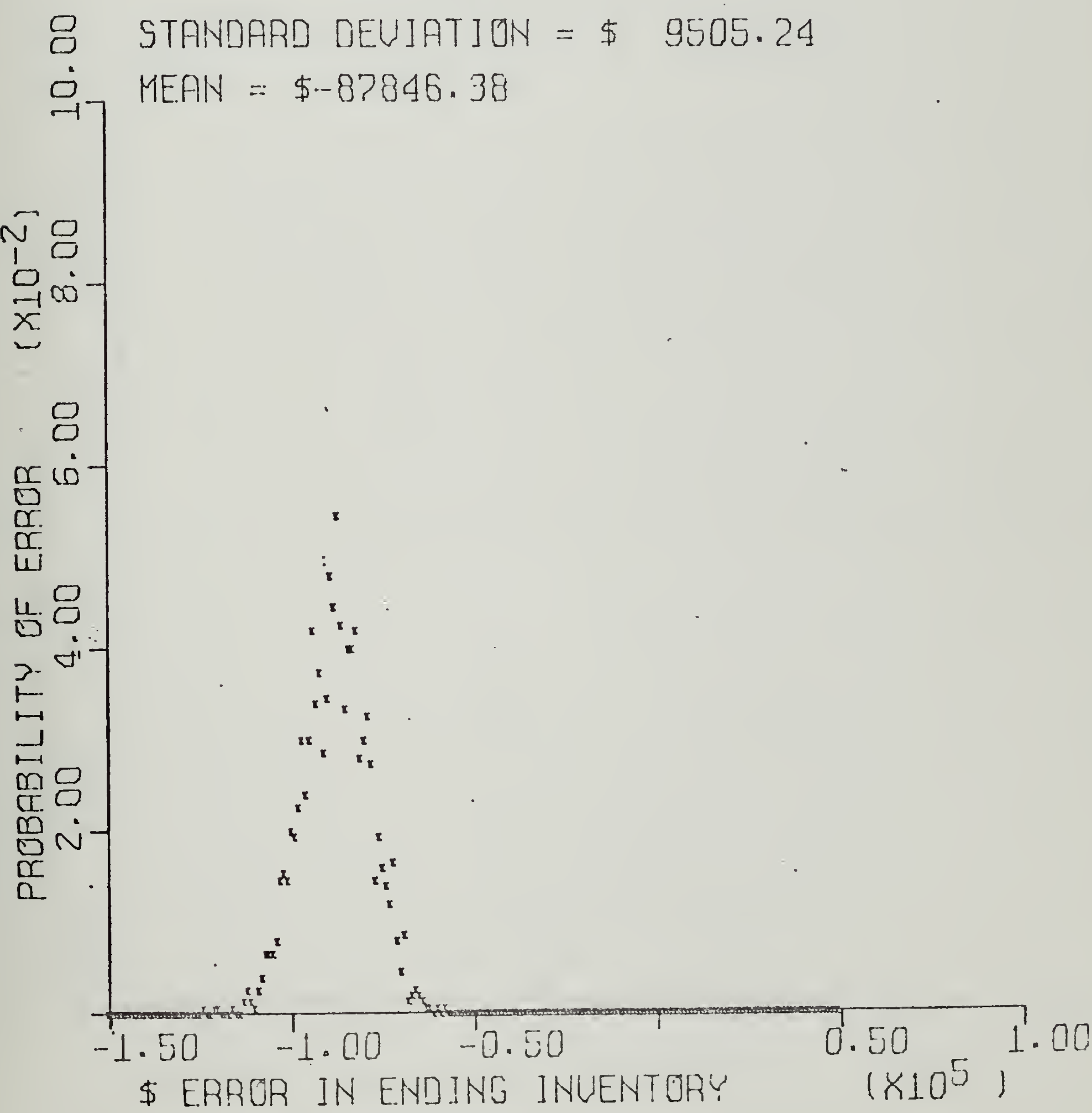


FIGURE C-11A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 5298.66
MEAN = $-48189.28

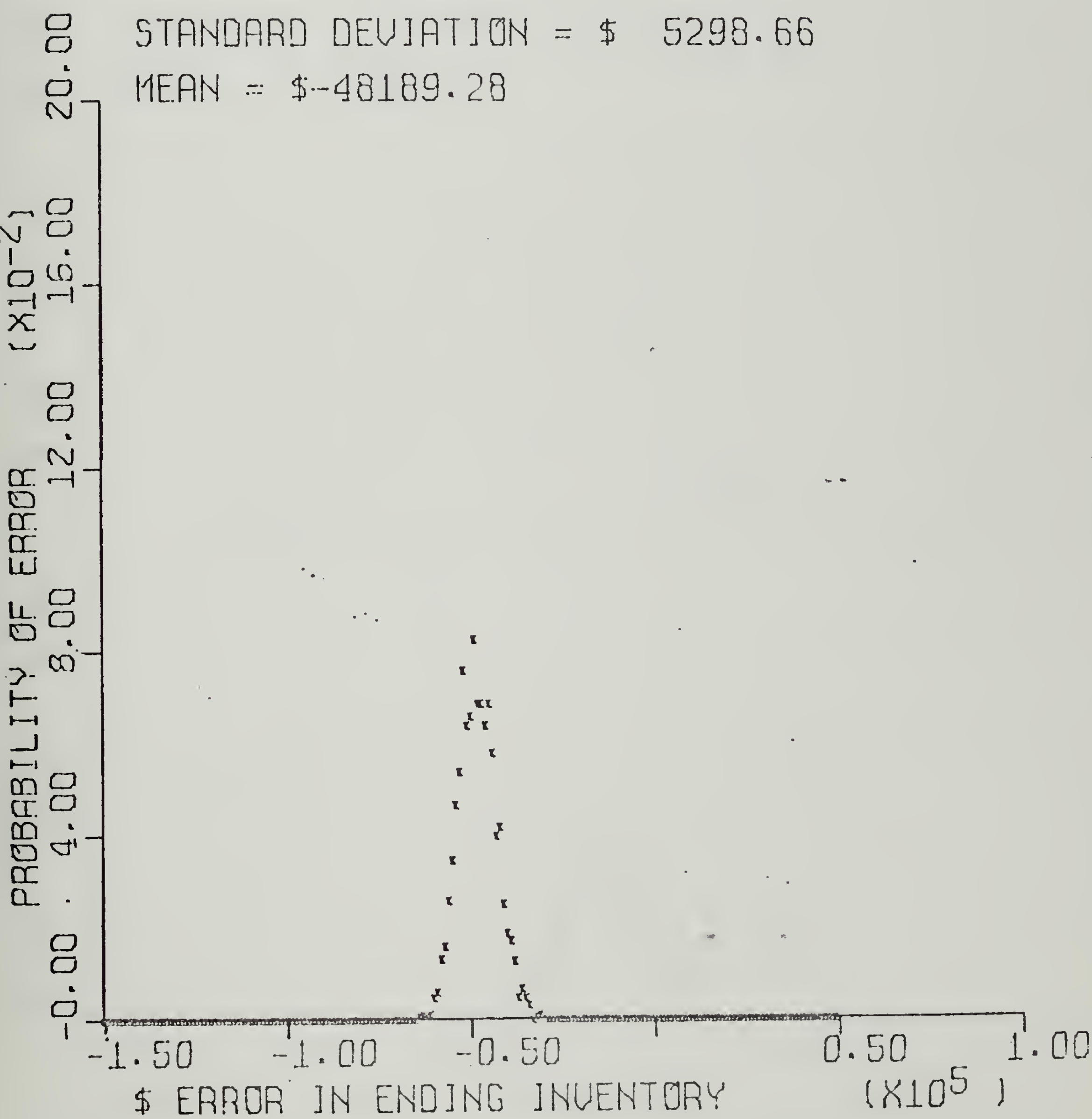


FIGURE C-11B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 10769.96
MEAN = $ -9009.17

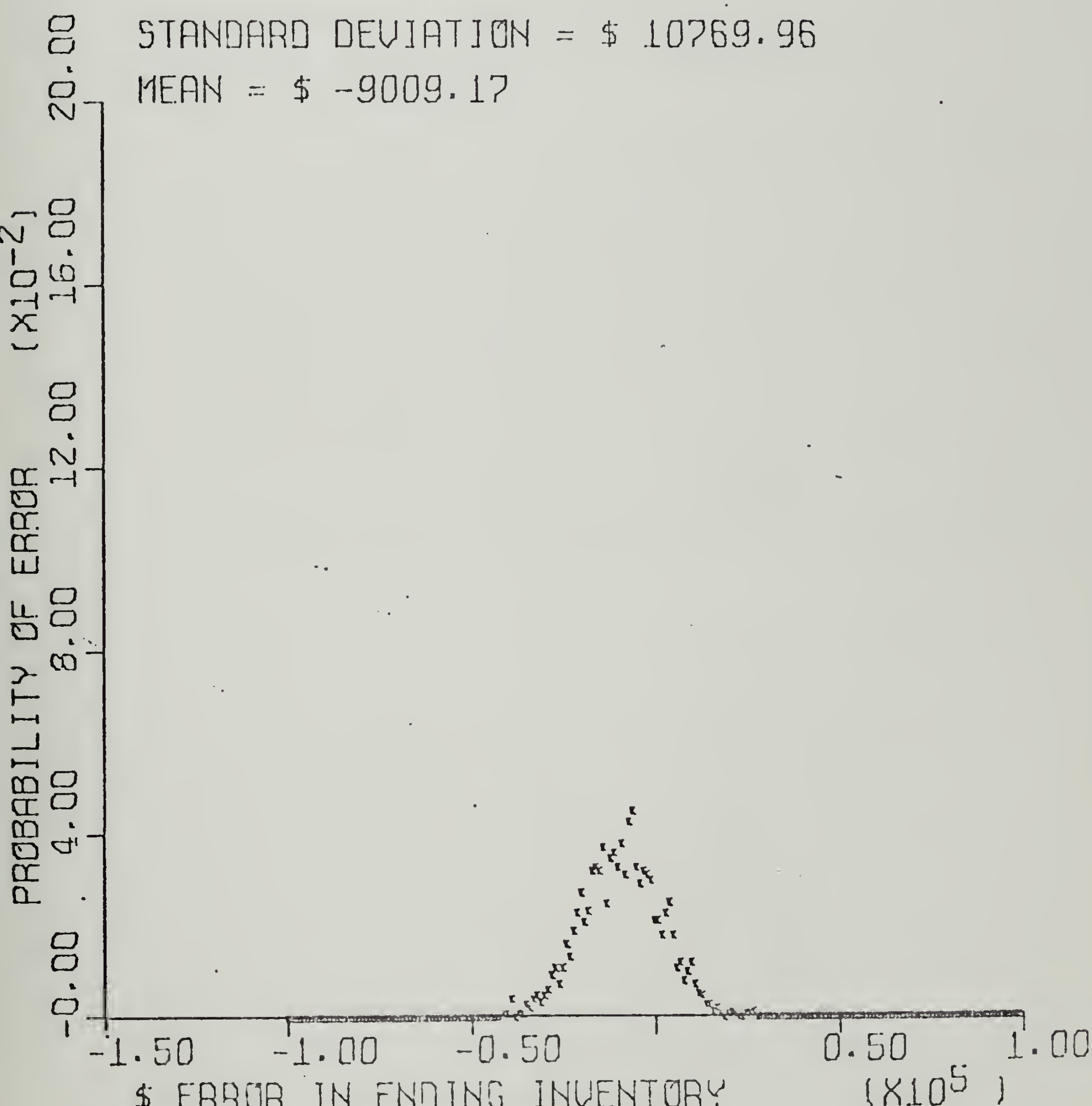


FIGURE C-11C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20688.29

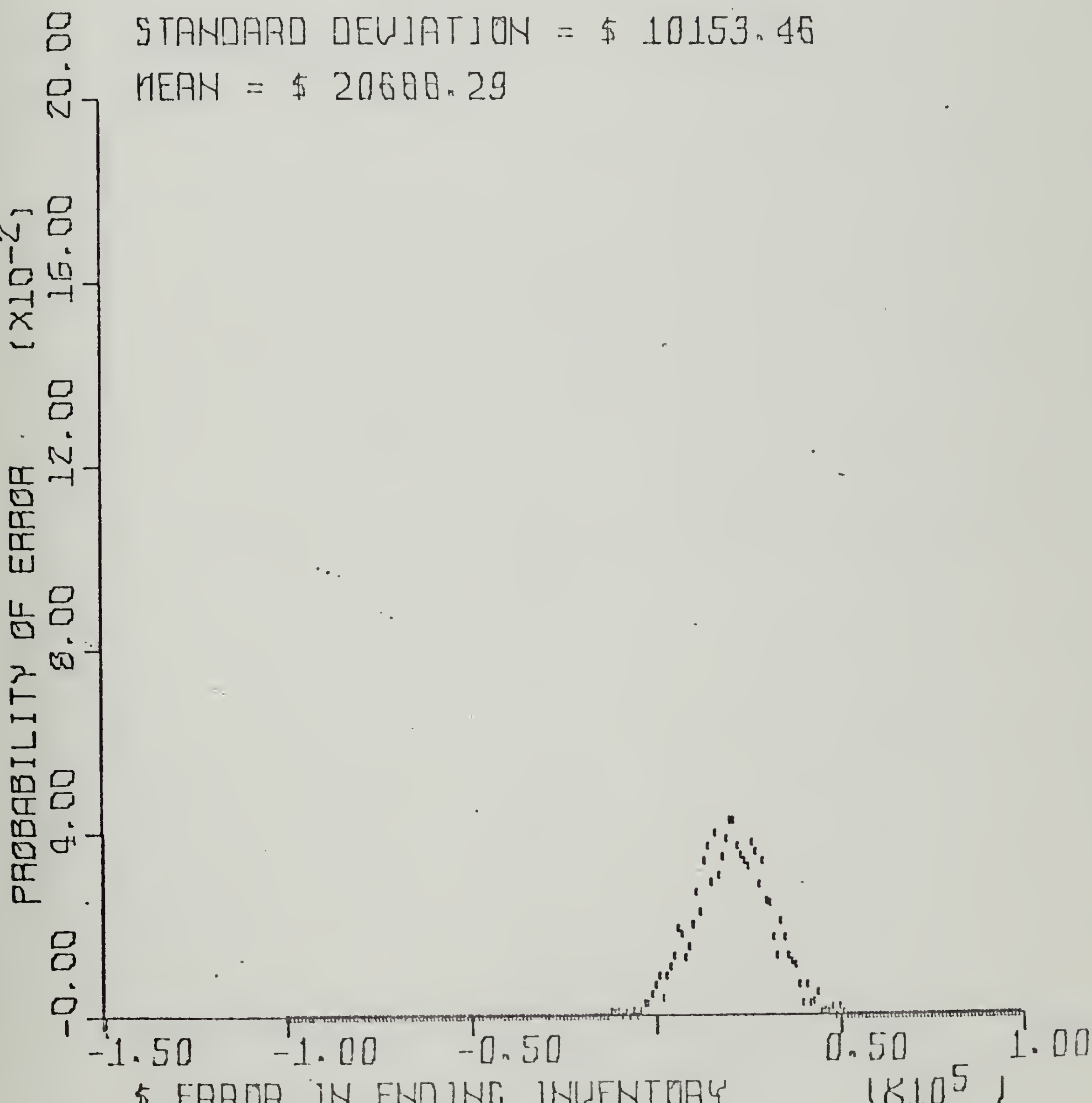


FIGURE C-110

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 3444.69
MEAN = $-35489.52

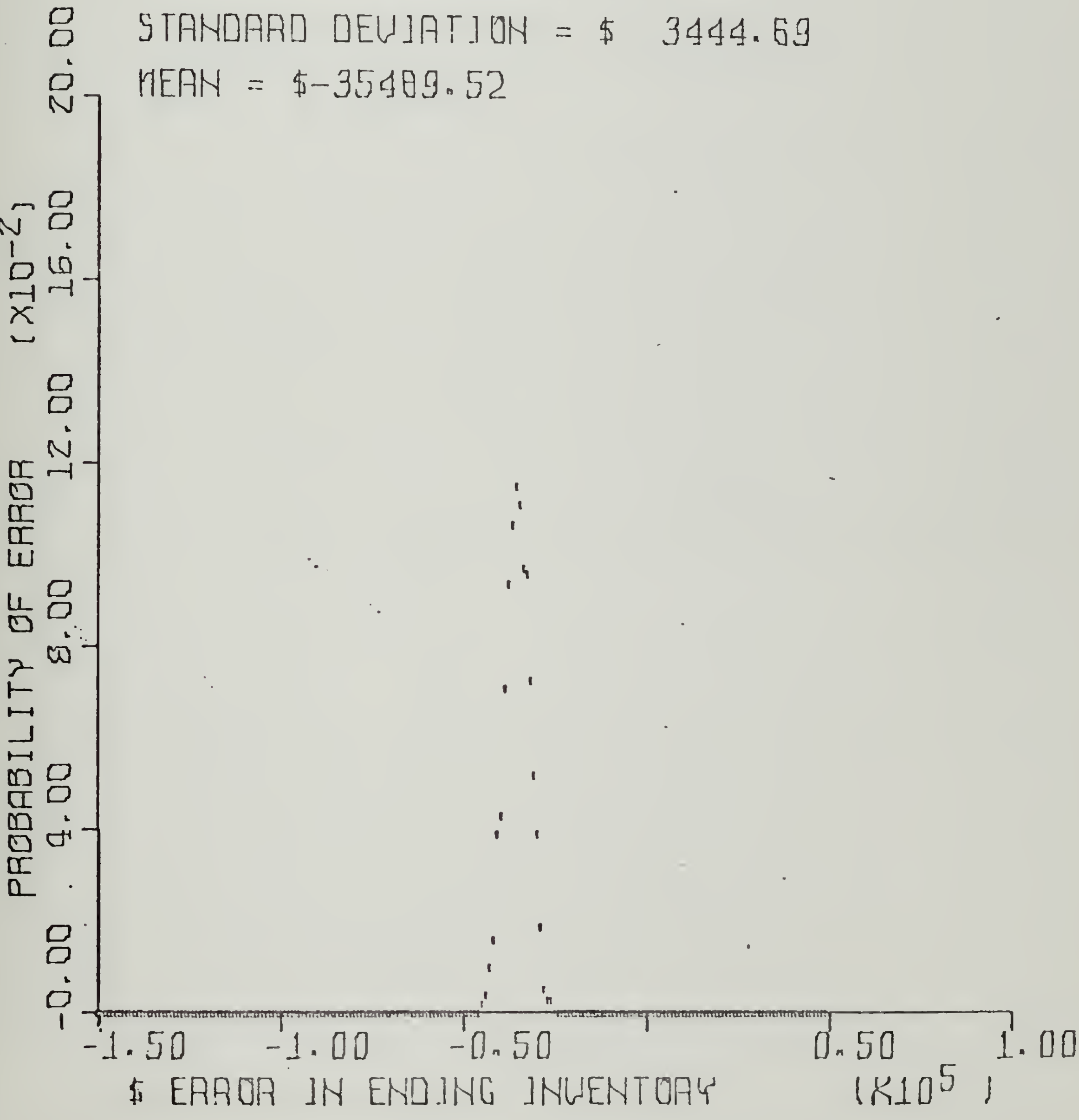


FIGURE C-12A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 3643.62
MEAN = $-59864.22

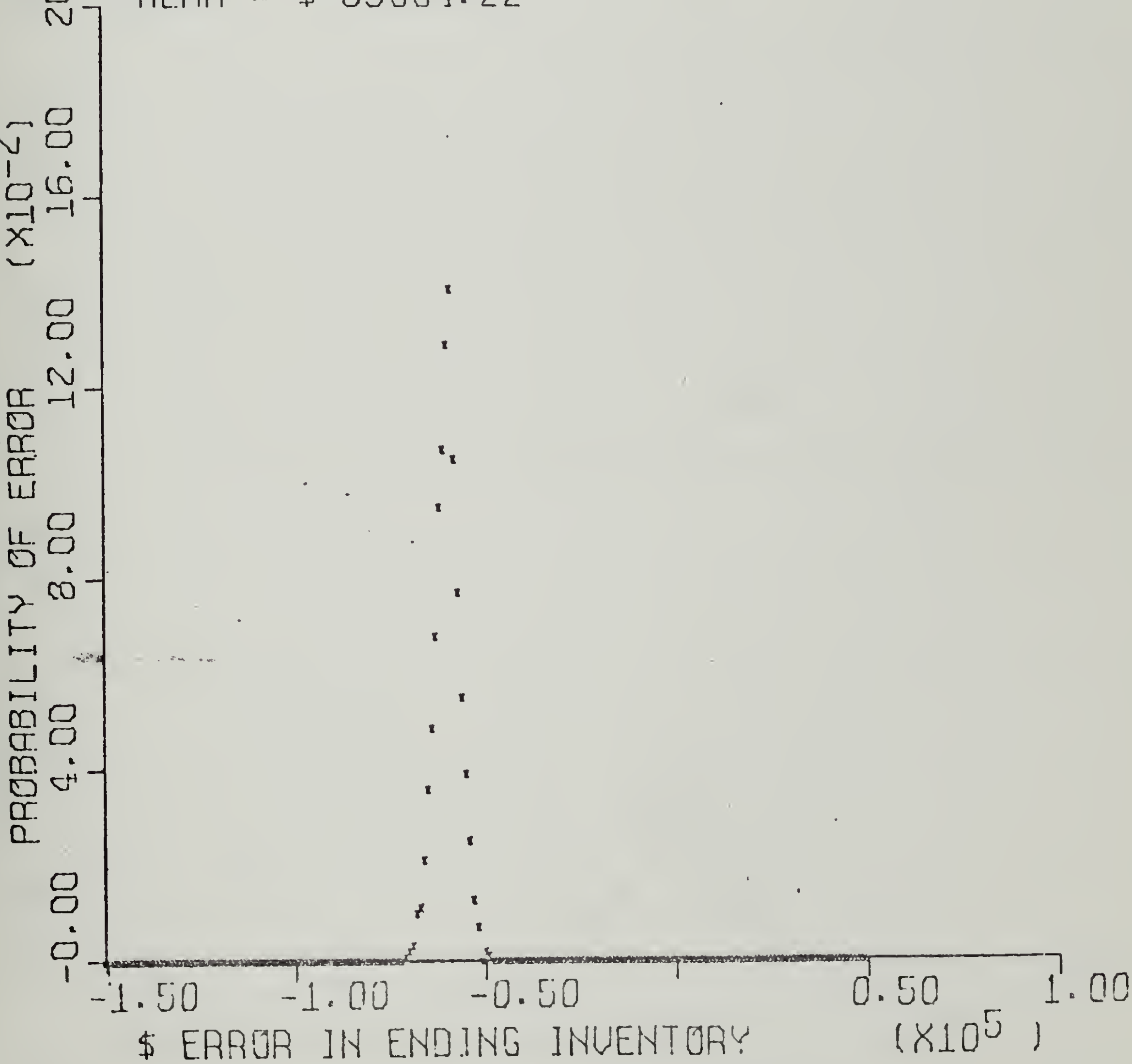


FIGURE C-12B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 10102.78
MEAN = $ 5246.98

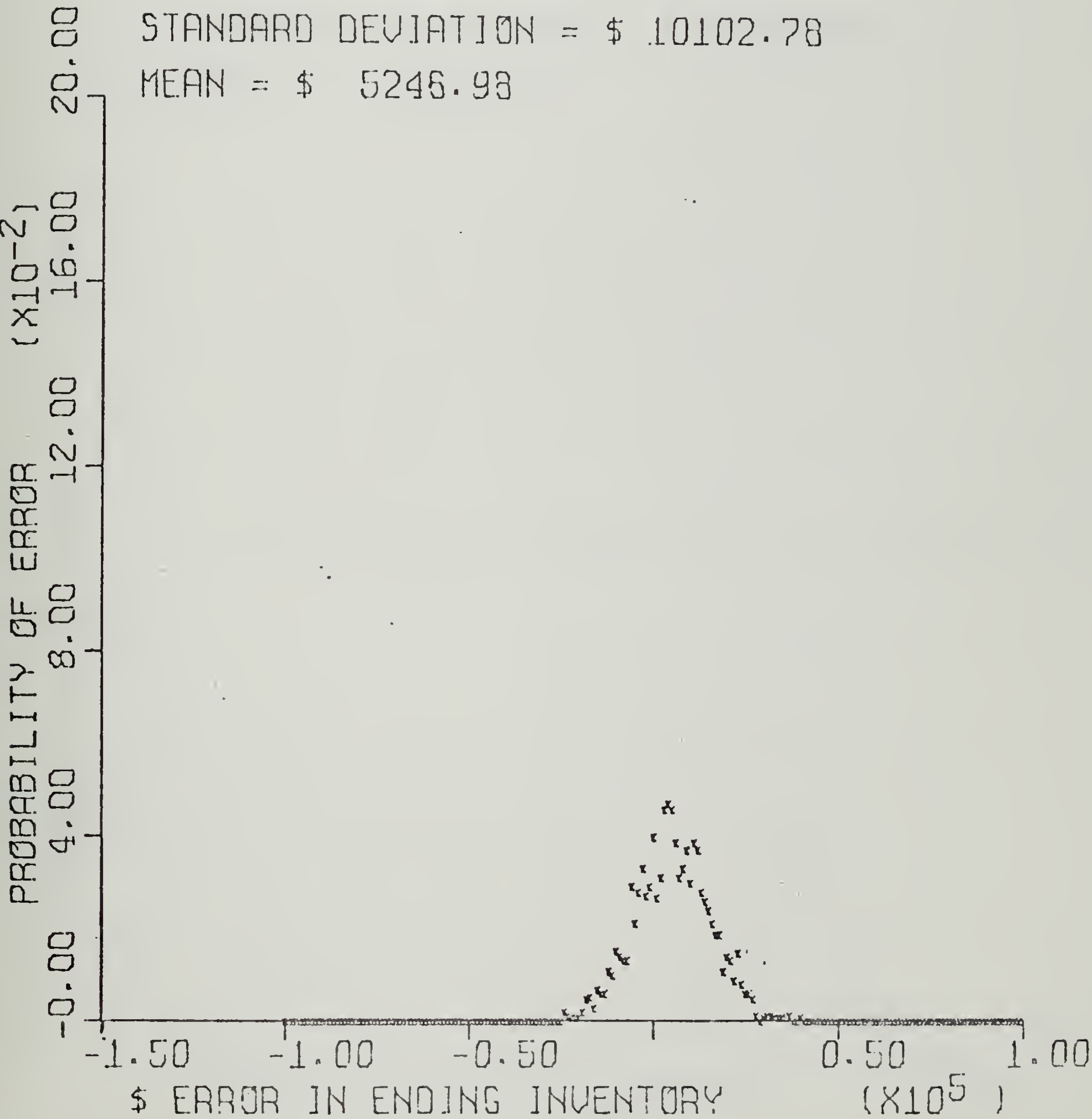


FIGURE C-12C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20600.29

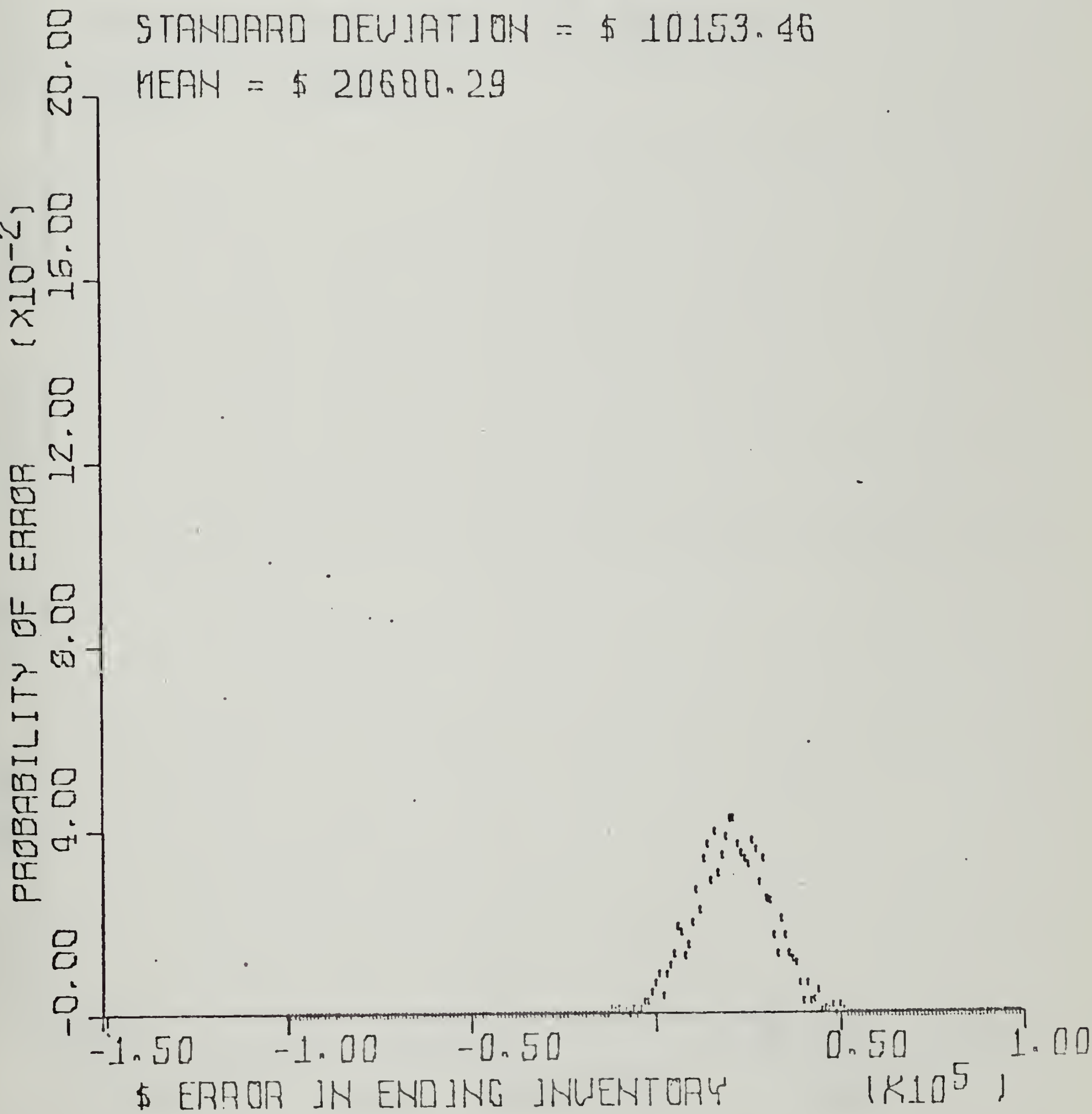


FIGURE C-12D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING) IN RAW
MATERIALS RECEIPT AND TRANSFER TO W-I-P
CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 3030.34
MEAN = $-32955.27

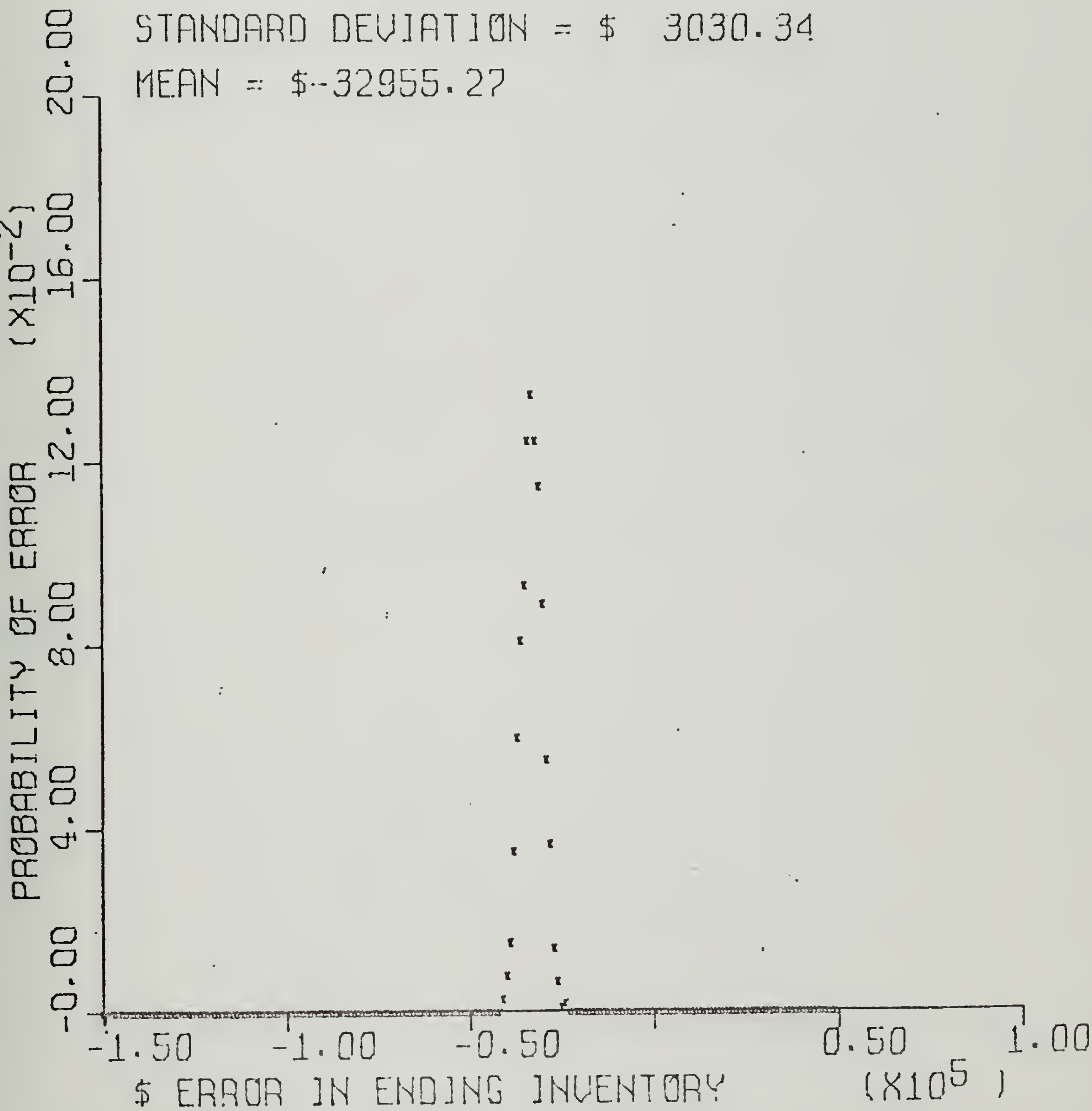


FIGURE C-13A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 15181.91
MEAN = $-61955.78

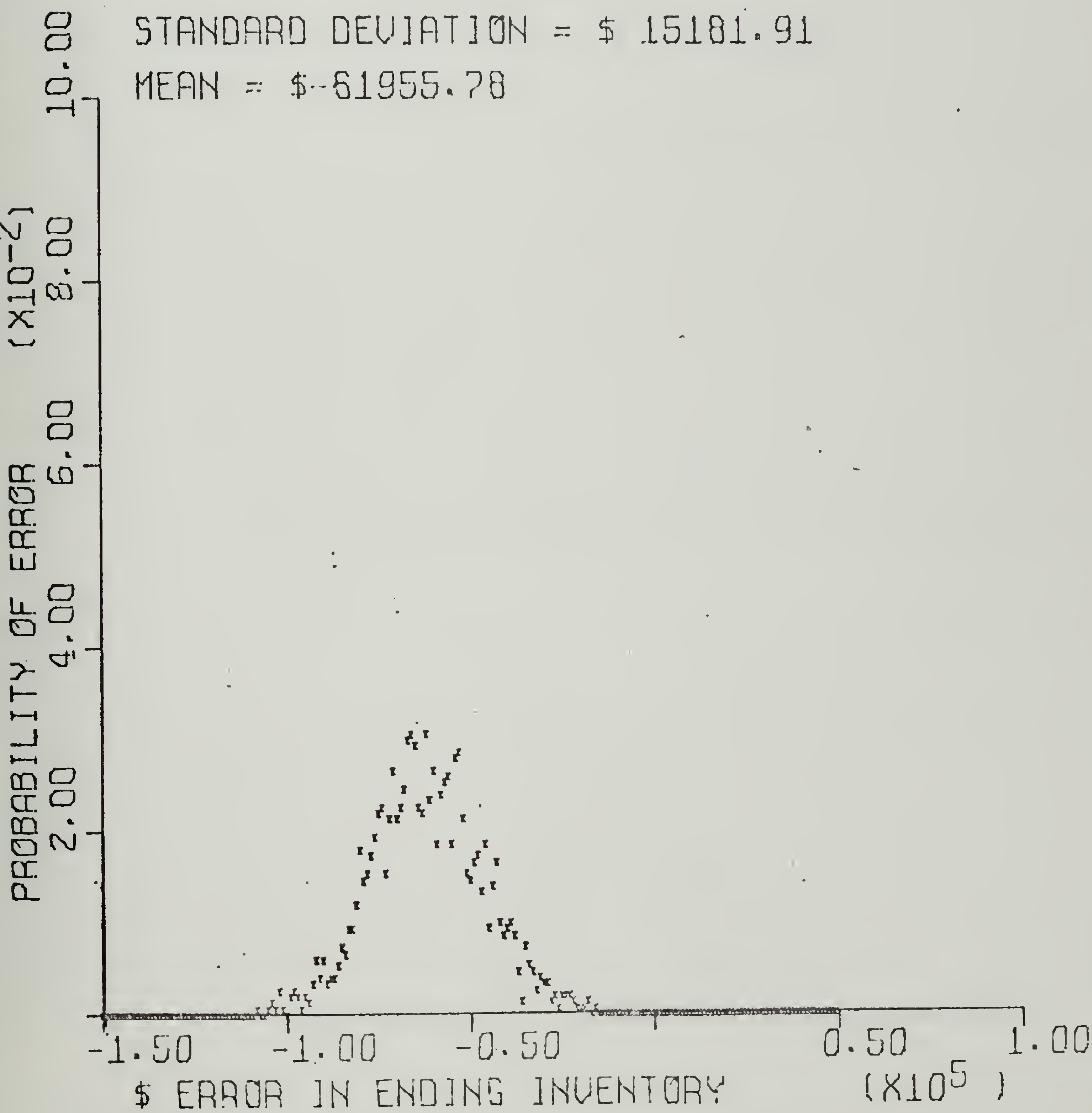


FIGURE C-13B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 14445.89
MEAN = $-11801.57

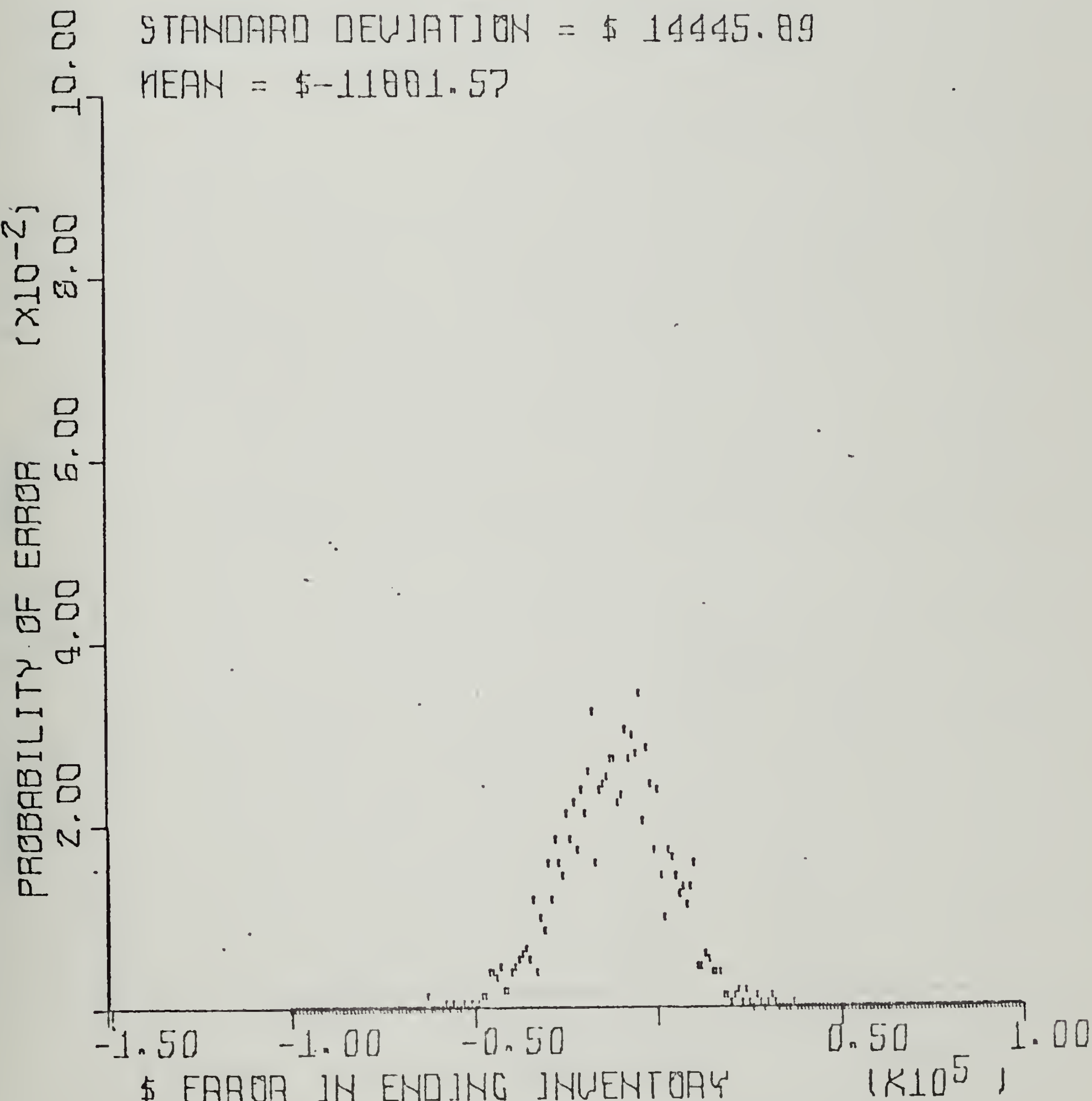


FIGURE C-13C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20688.29

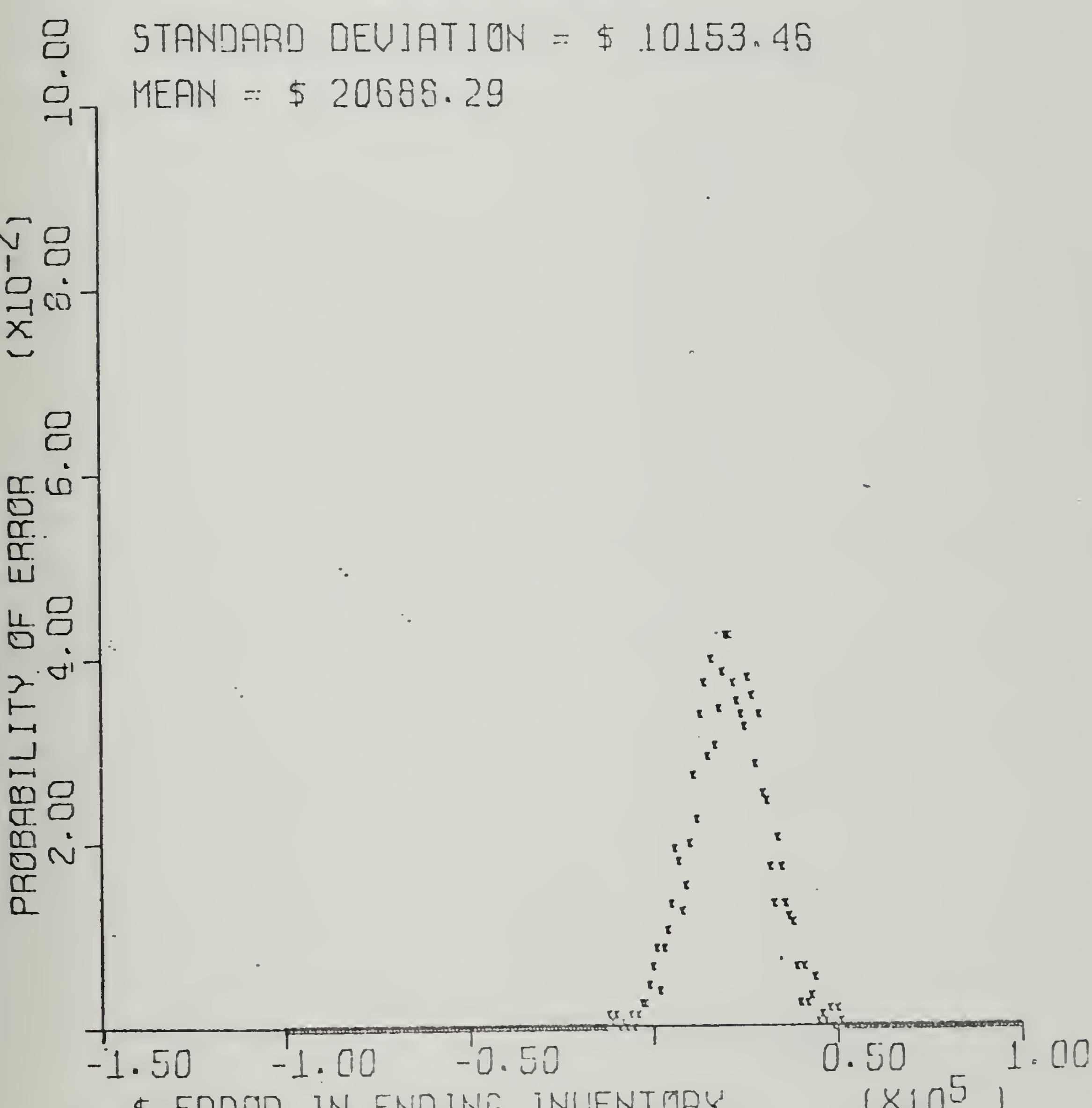


FIGURE C-130

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 11142.39
MEAN = $-52148.55

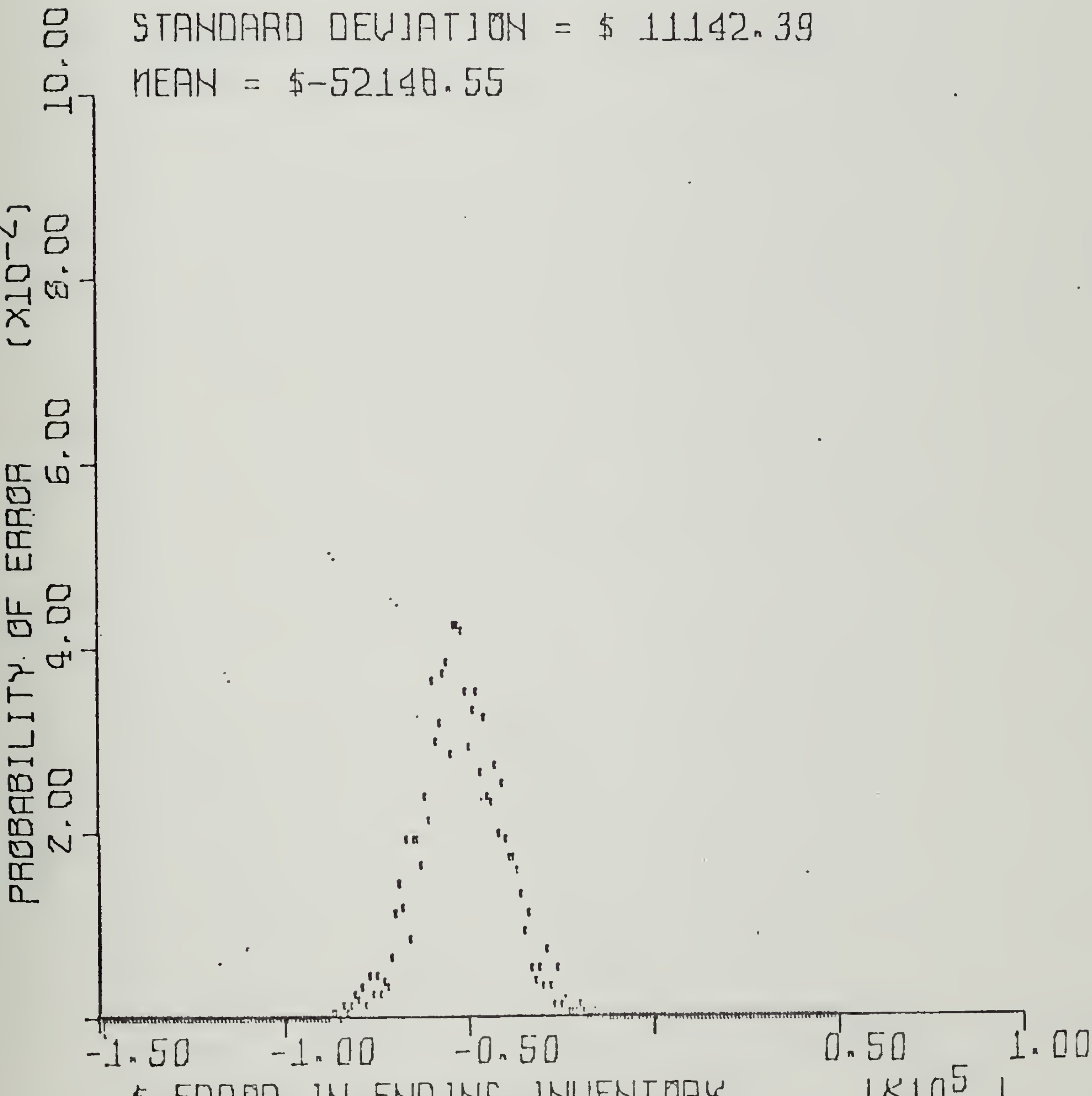


FIGURE C-14A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 12659.23
MEAN = $-38495.32

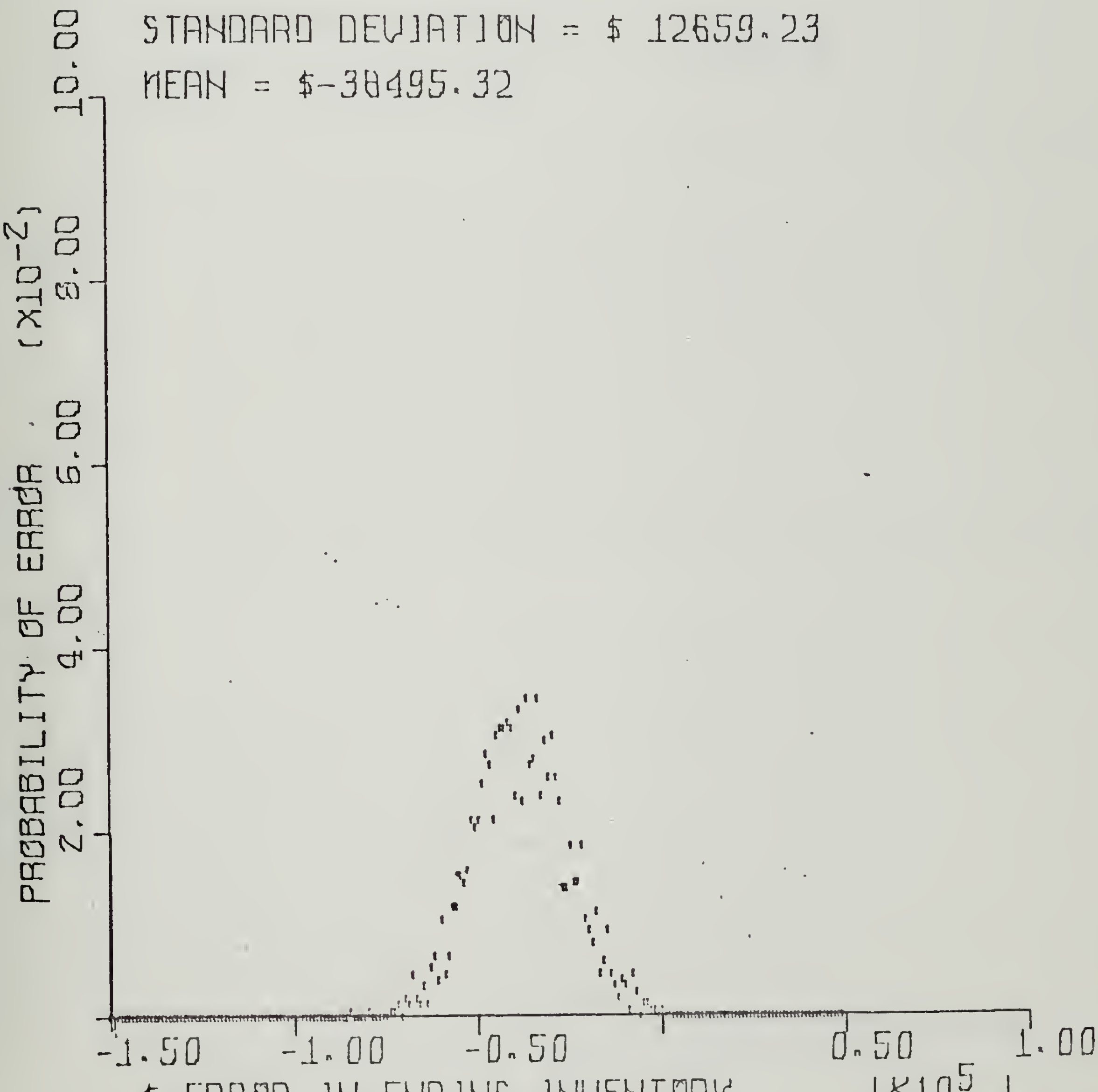


FIGURE C-14B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 13150.48
MEAN = $-47117.05

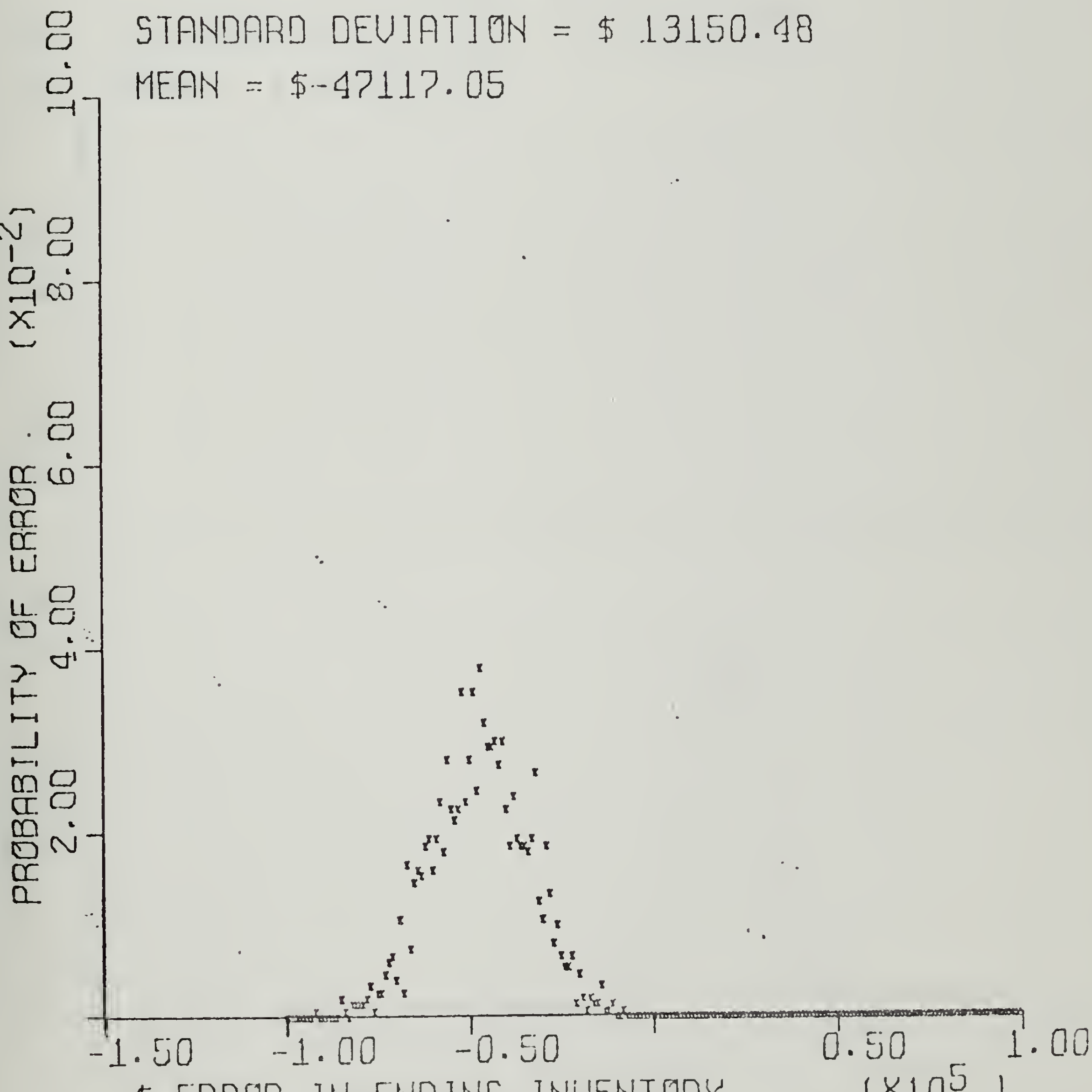


FIGURE C-14C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20688.29

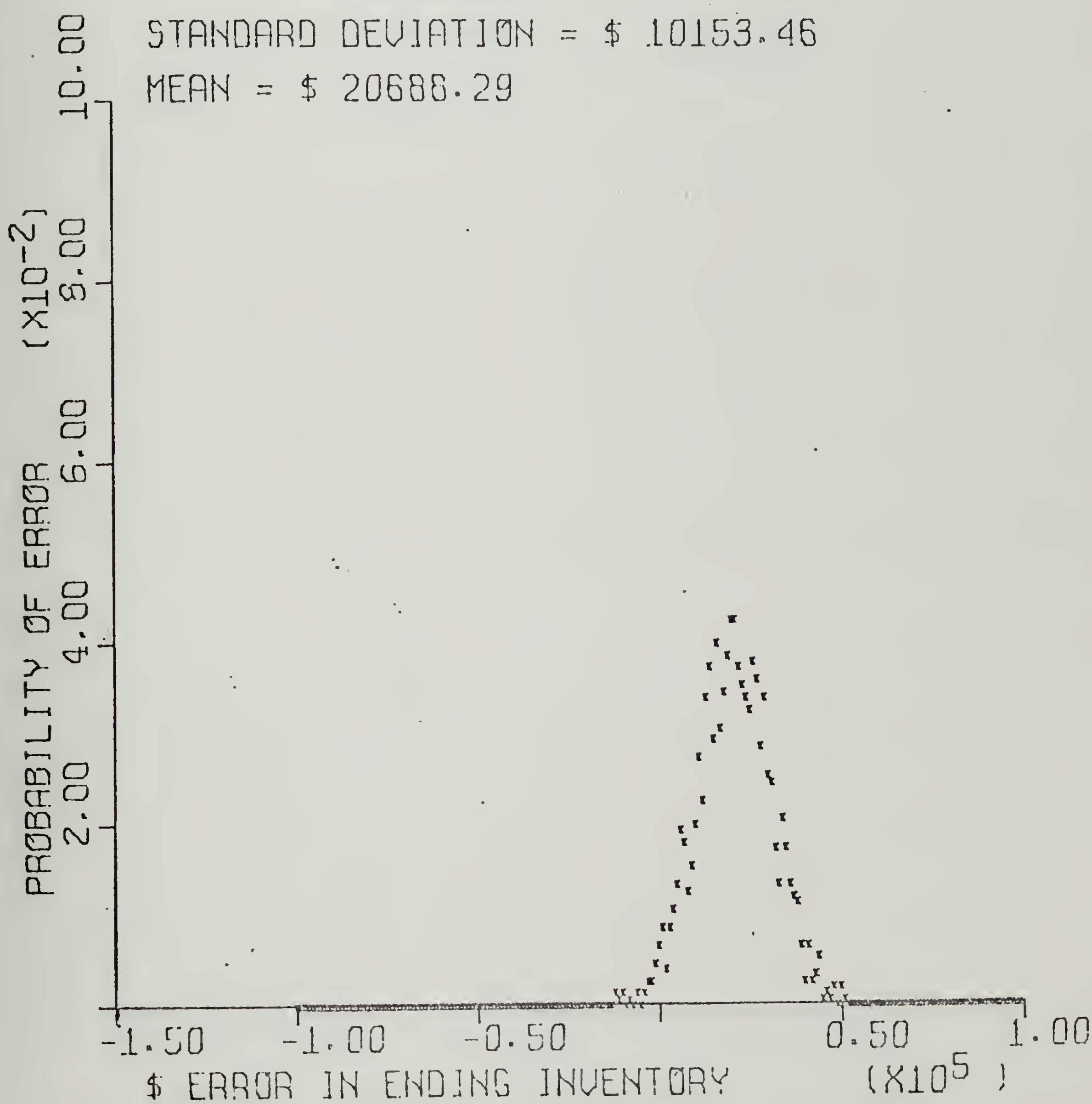


FIGURE C-14D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 9518.25
MEAN = $-63907.96

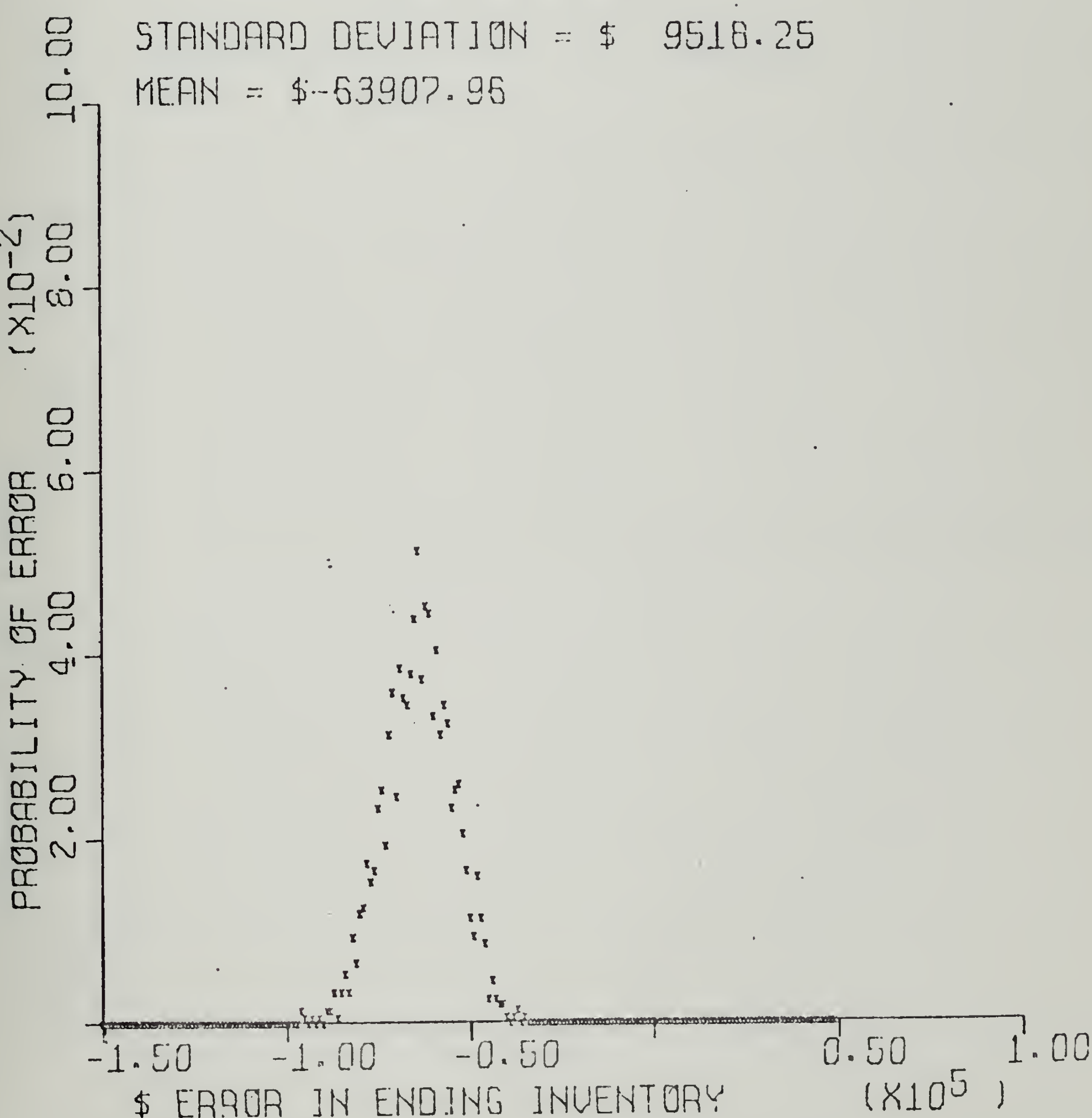


FIGURE C-15A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 3983.62
MEAN = $ 8660.01

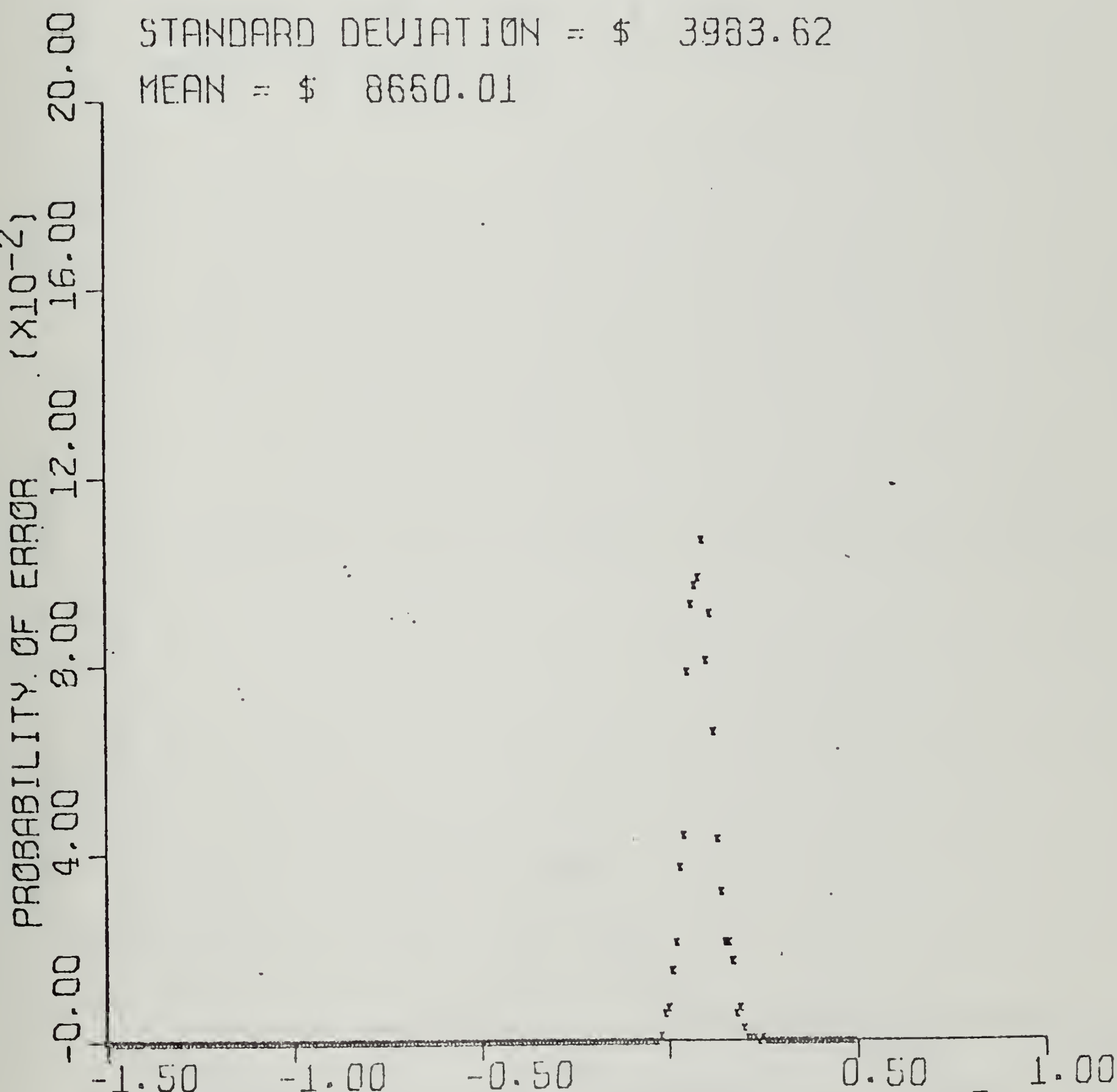


FIGURE C-15B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 10018.82
MEAN = $-28371.64

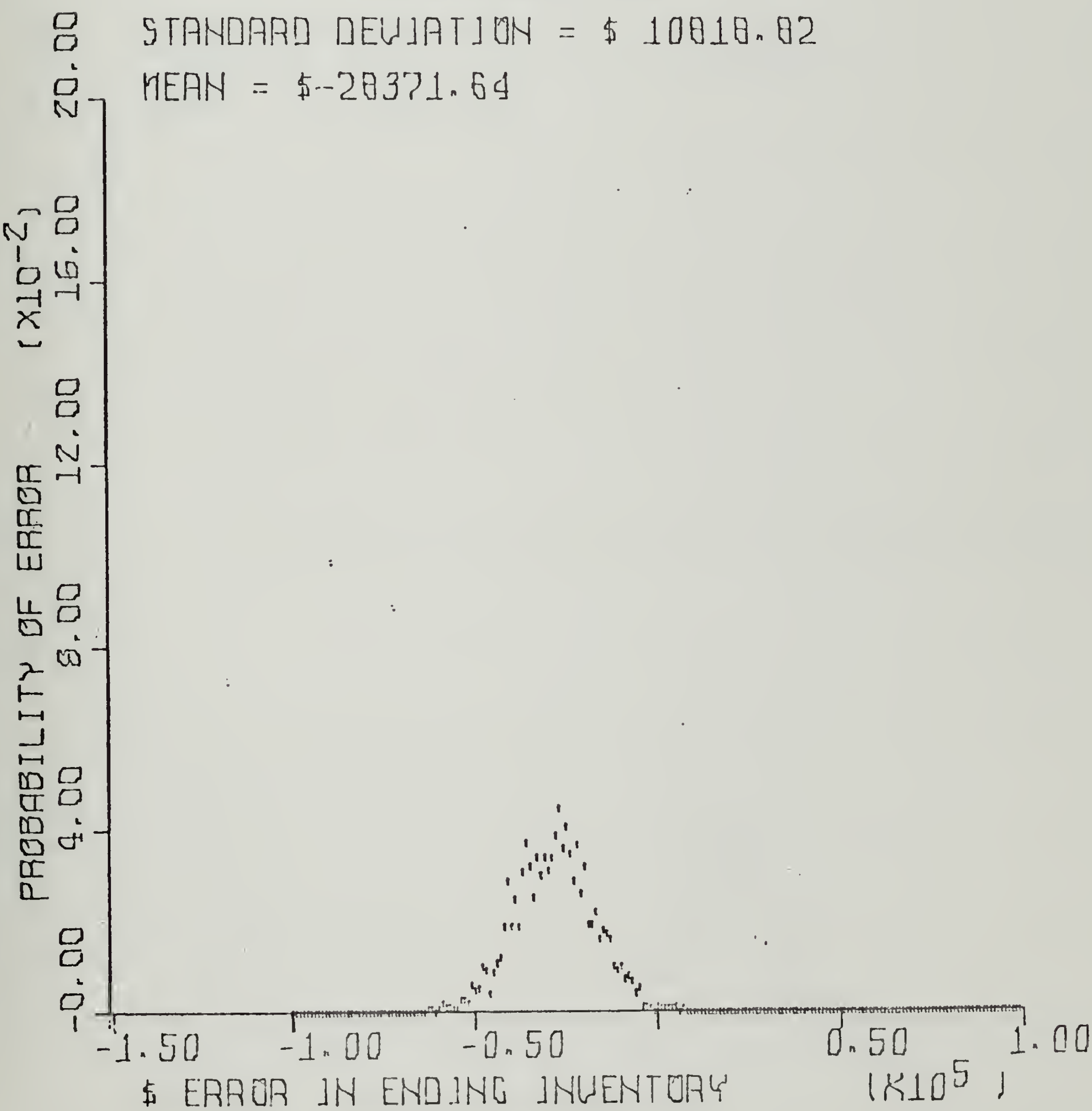


FIGURE C-15C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20688.29

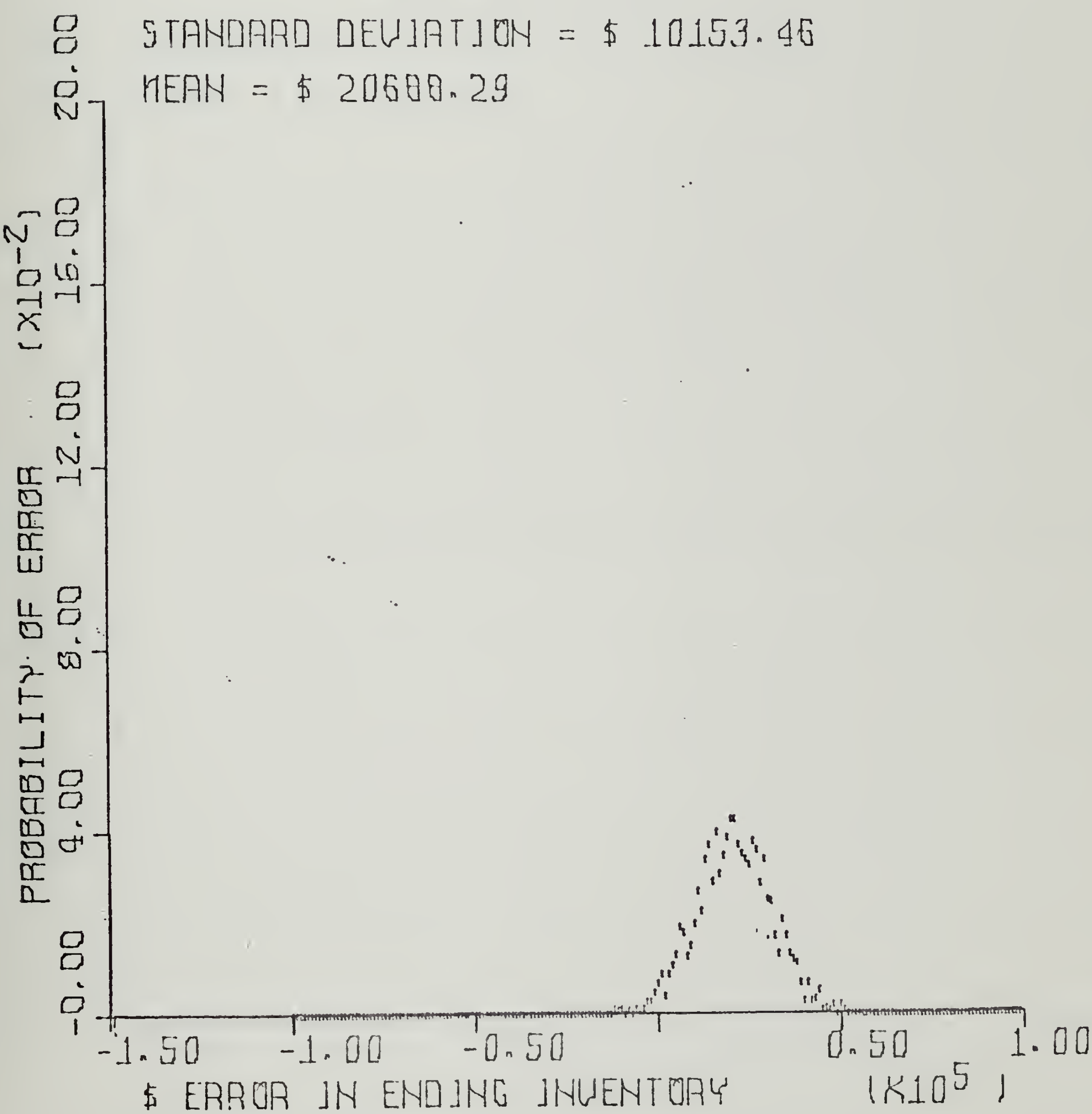


FIGURE C-15D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 2105.67
MEAN = $ 1969.94

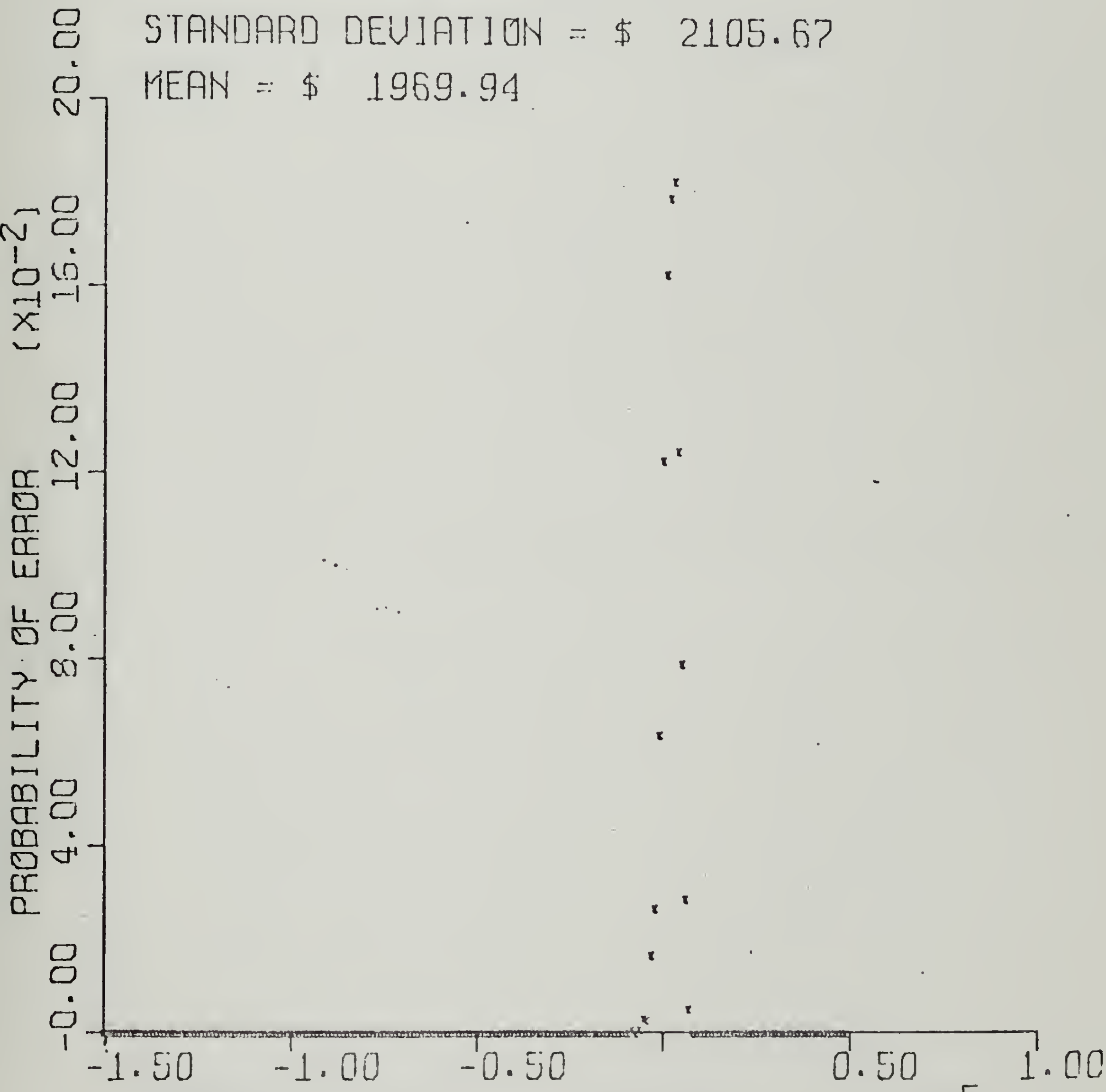


FIGURE C-16A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 0.0

MEAN = $ 0.0

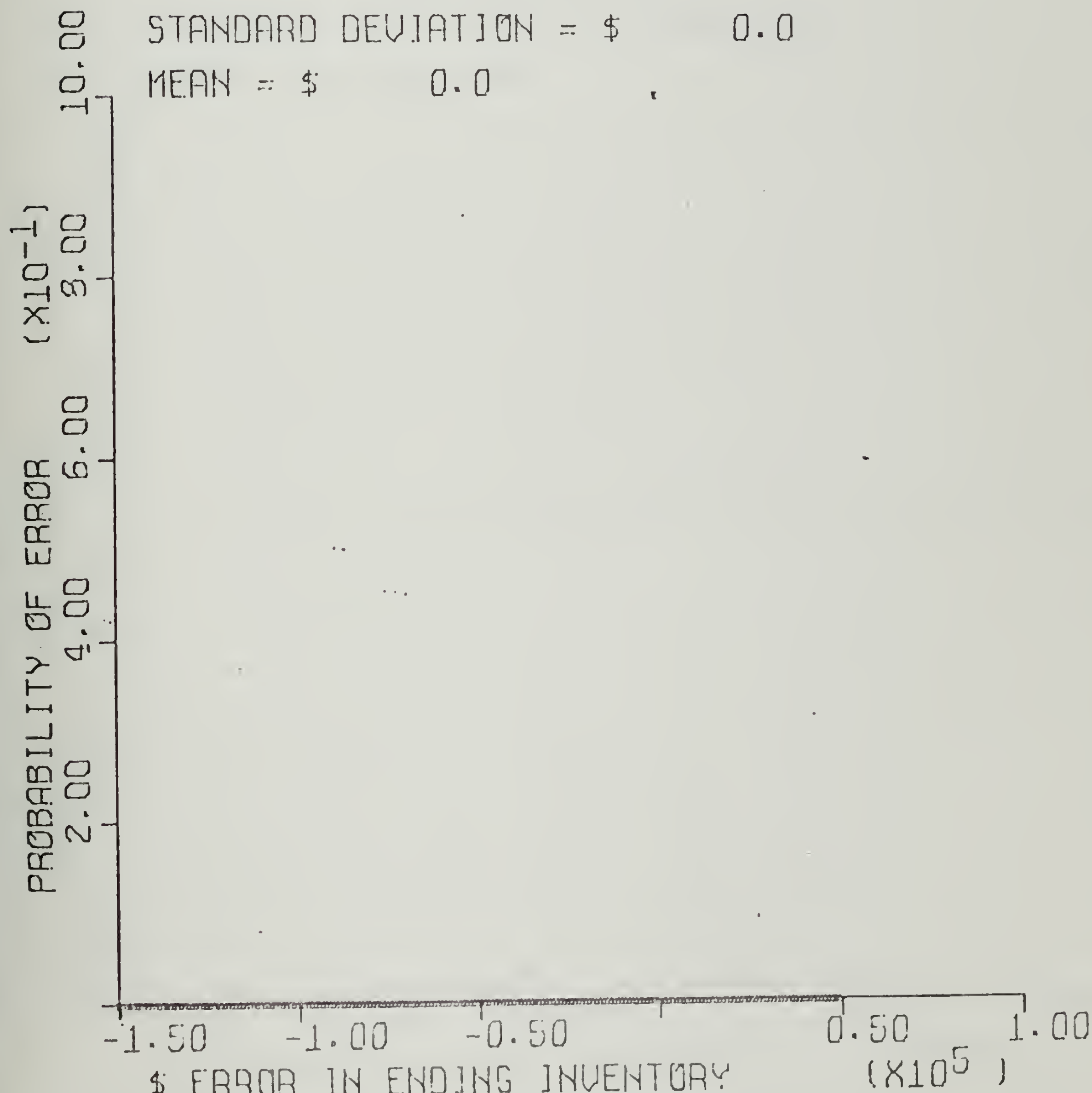


FIGURE C-16B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 10146.91
MEAN = $-15614.98

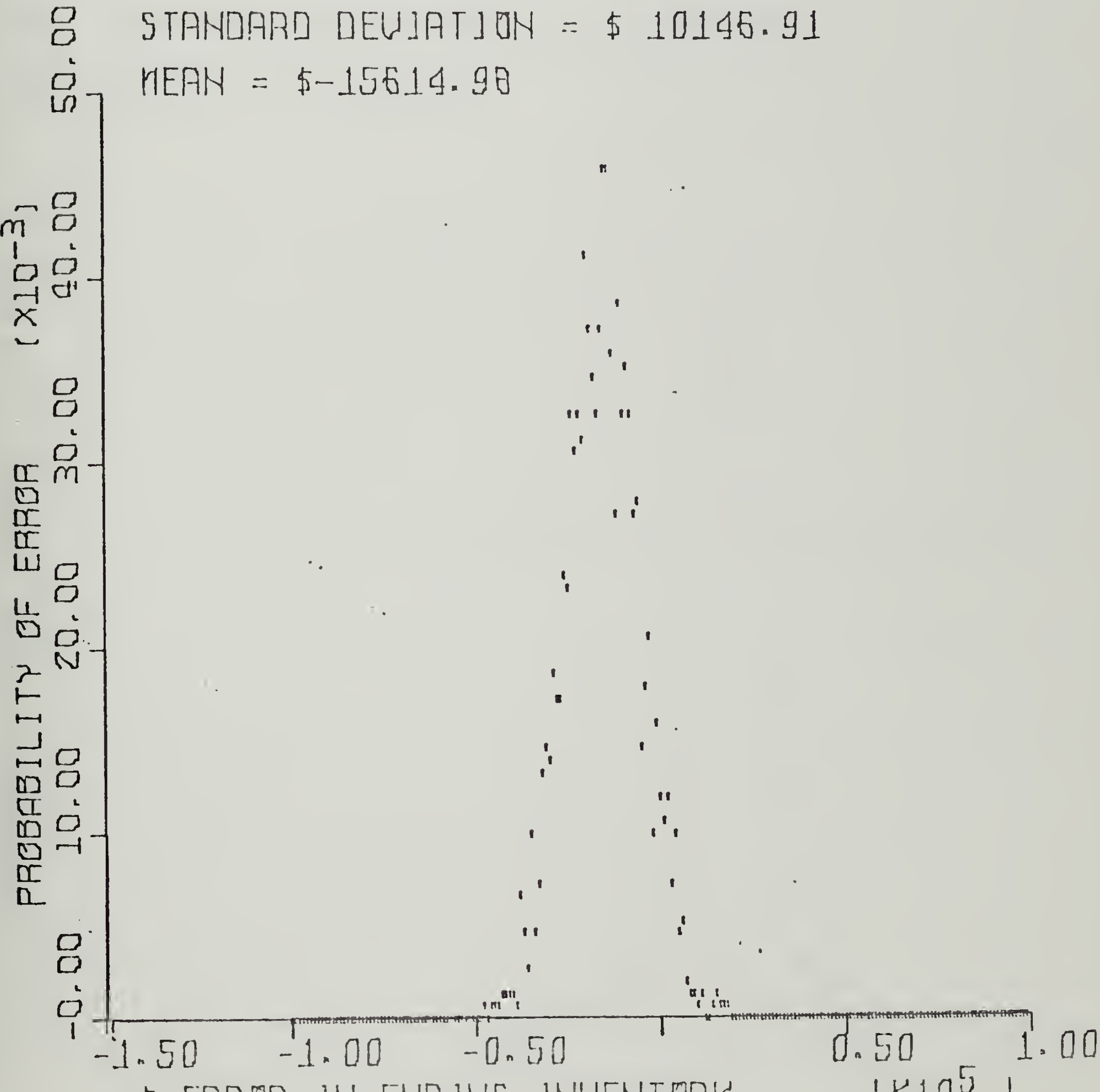


FIGURE C-16C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANS-
FER TO W-I-P CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 10153.46
MEAN = $ 20688.29

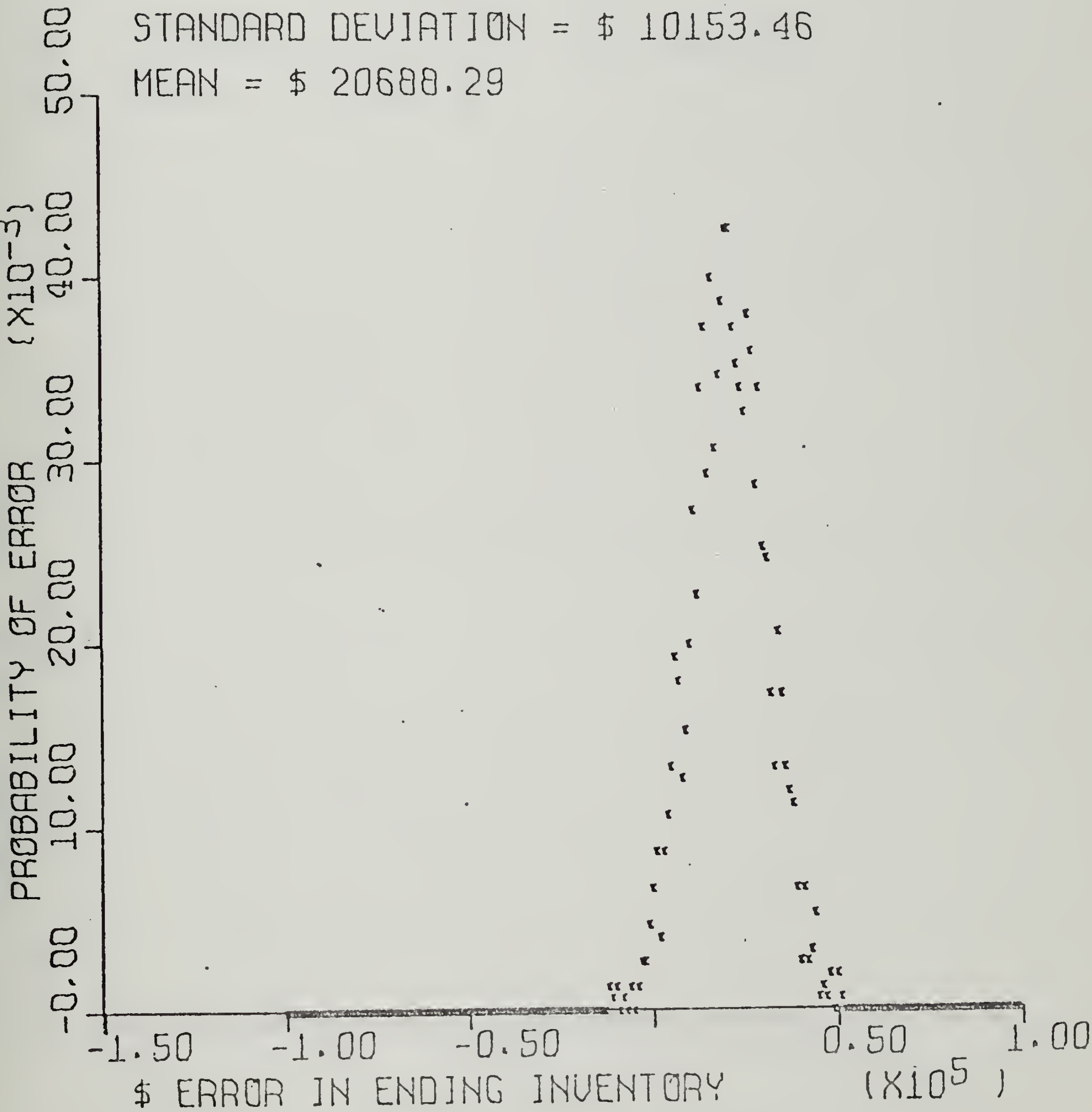


FIGURE C-16D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS RECEIPT AND TRANSFER TO W-I-P CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 1176.03
MEAN = $ 5567.98

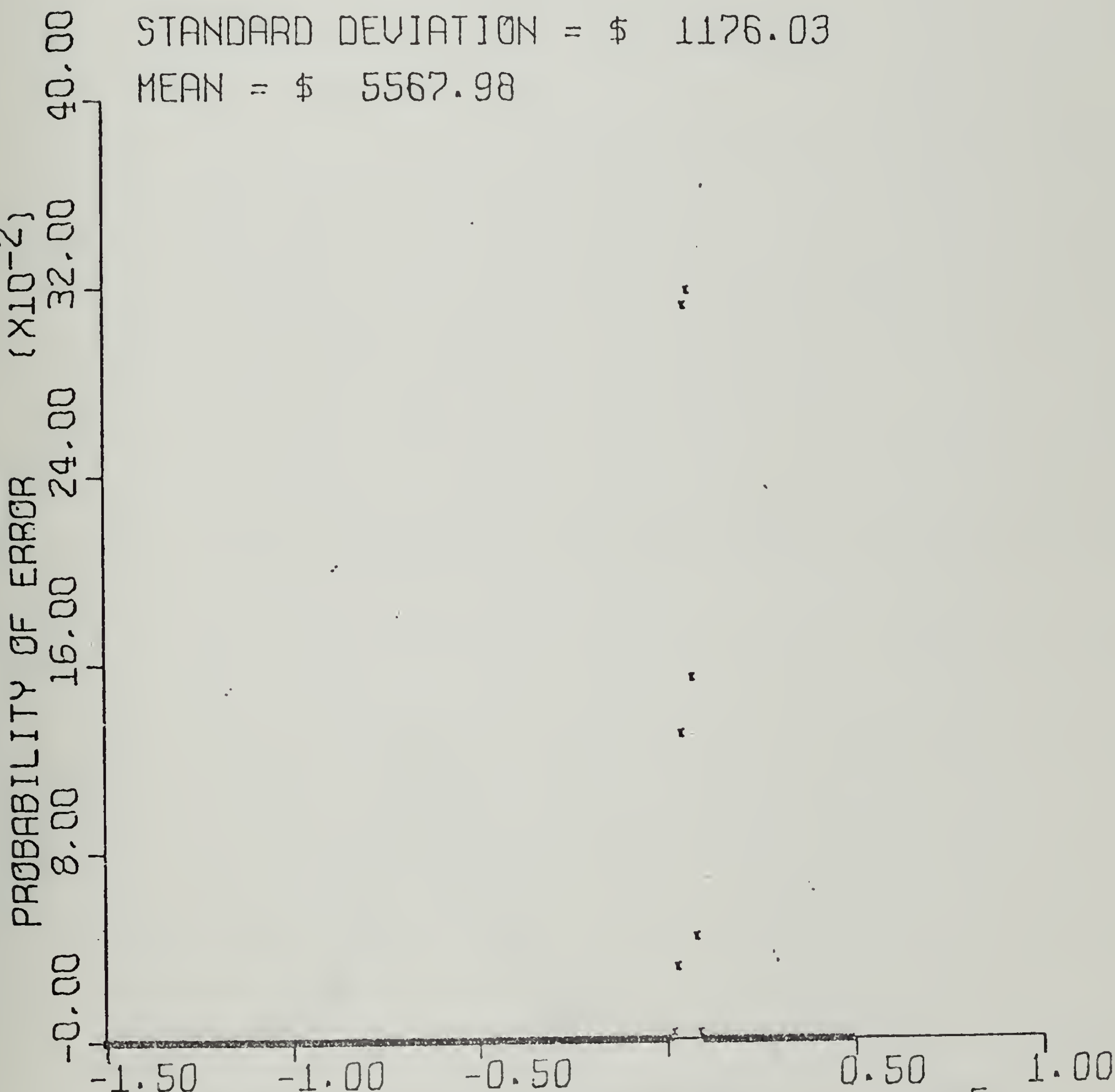


FIGURE C-17A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 15183.88
MEAN = $--61954.68

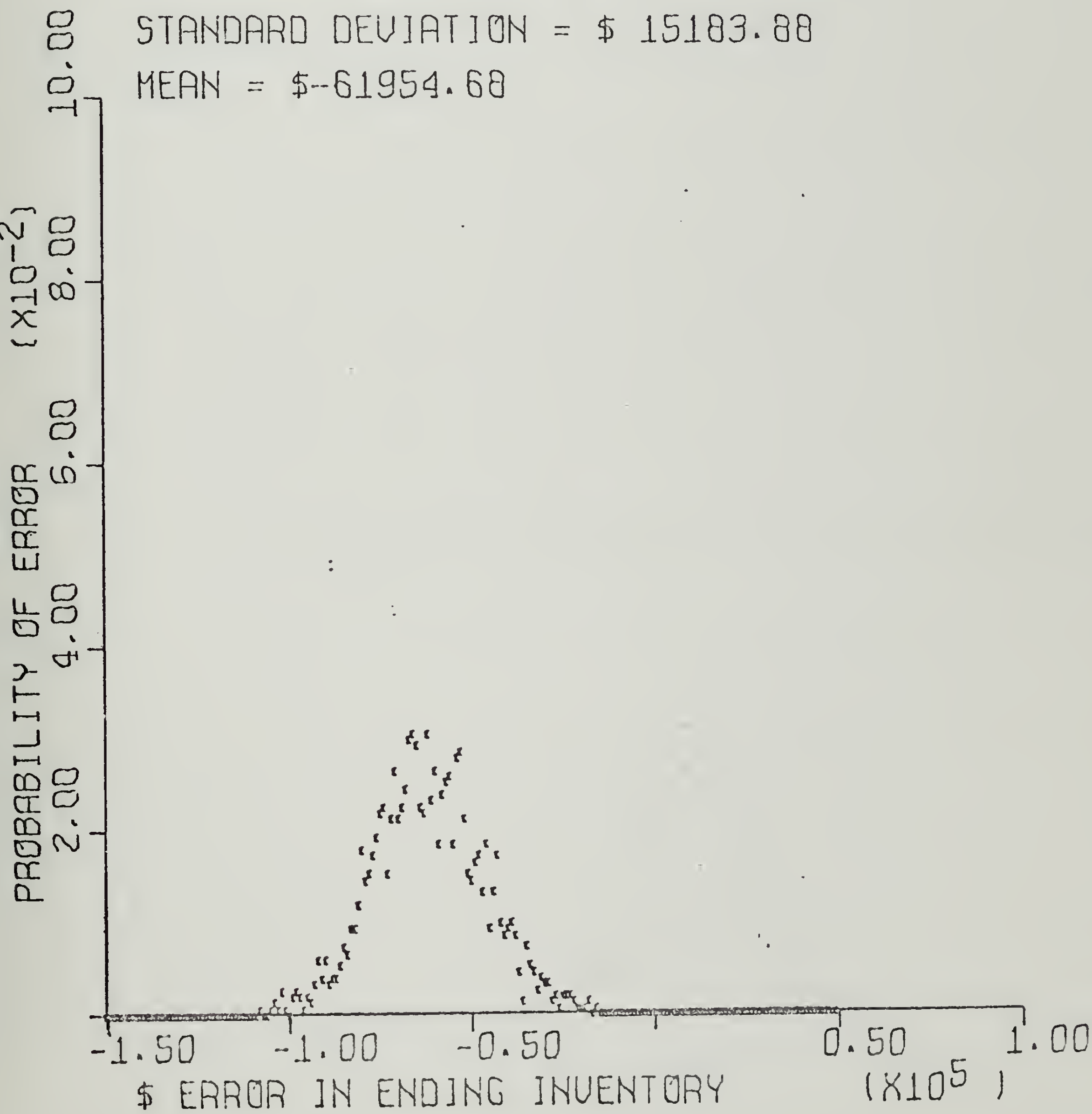


FIGURE C-17B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS; TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 13285.04
MEAN = $ 10756.26

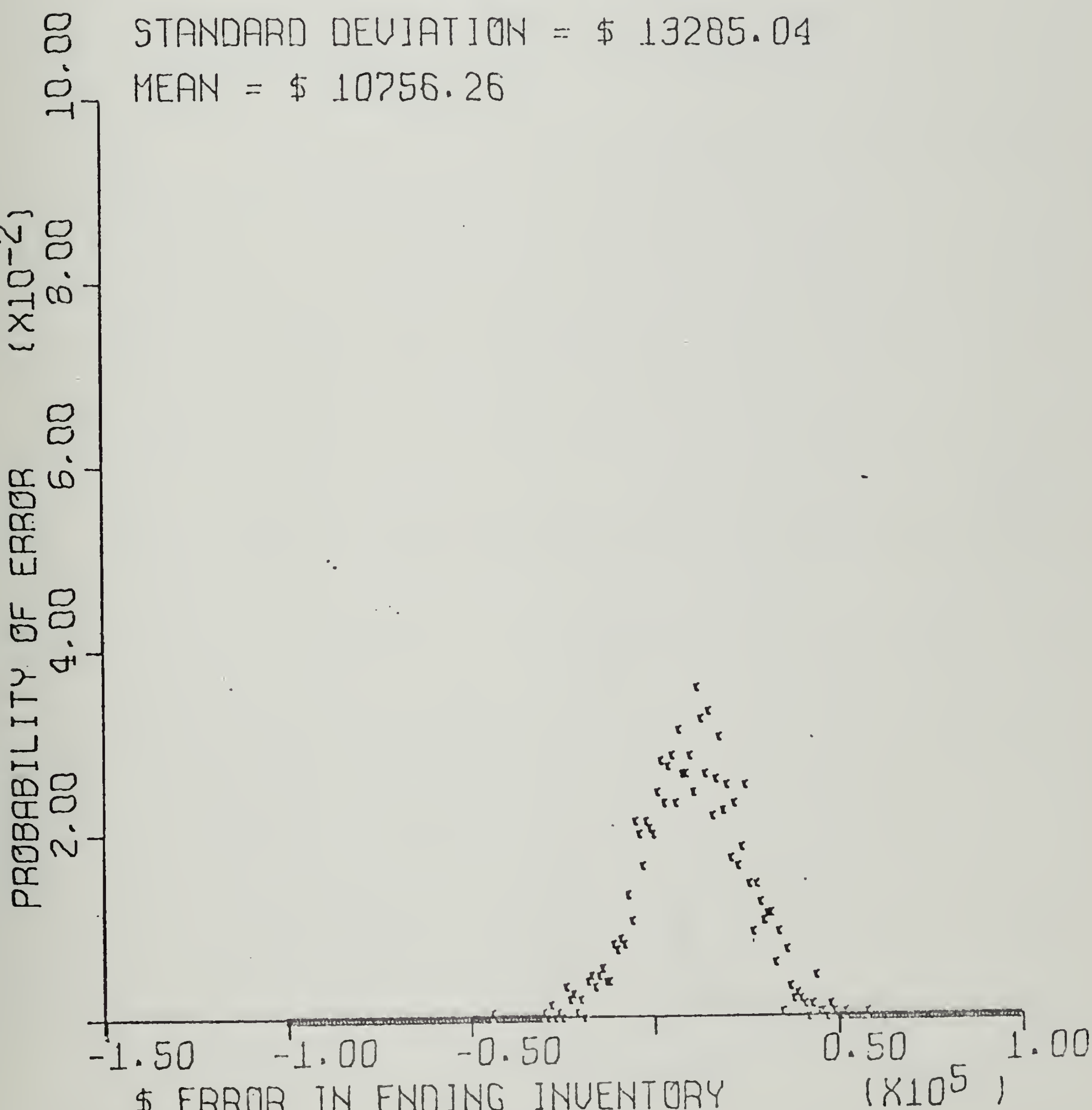


FIGURE C-17C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = \$ 8554.31
MEAN = \$ -8584.92

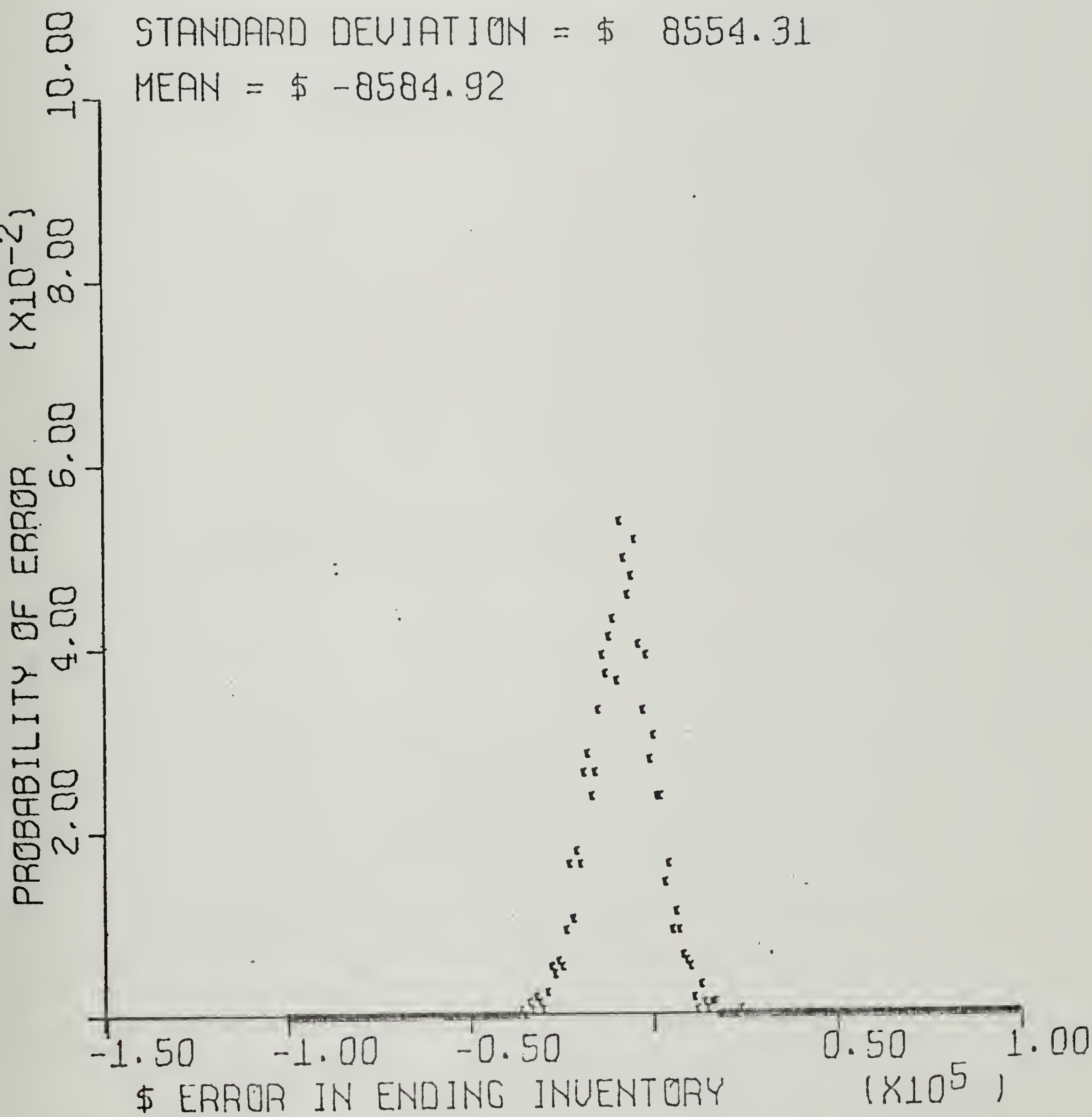


FIGURE C-17D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 11103.76
MEAN = $-58784.32

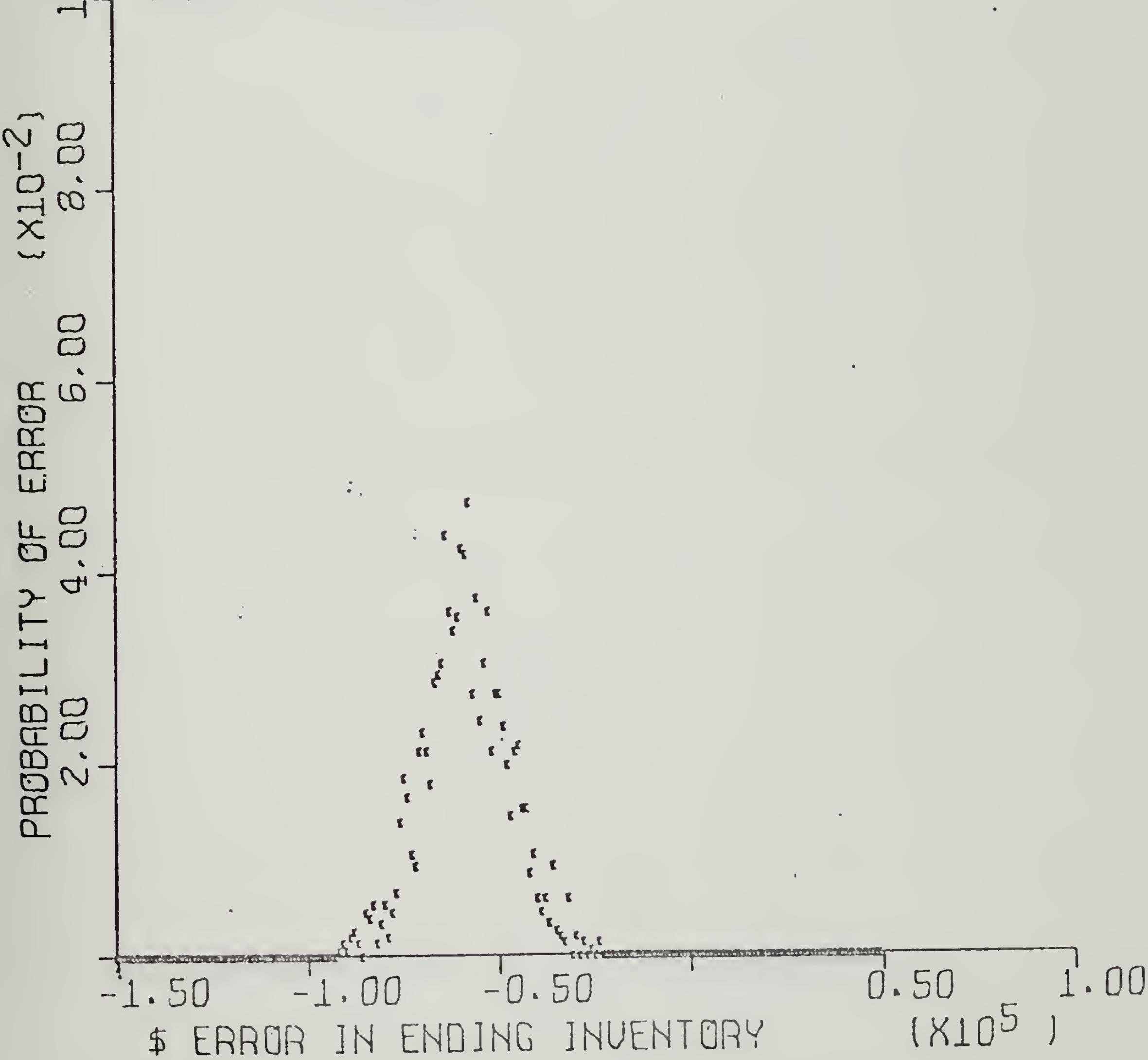


FIGURE C-18A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 12659.23
MEAN = $-38495.32

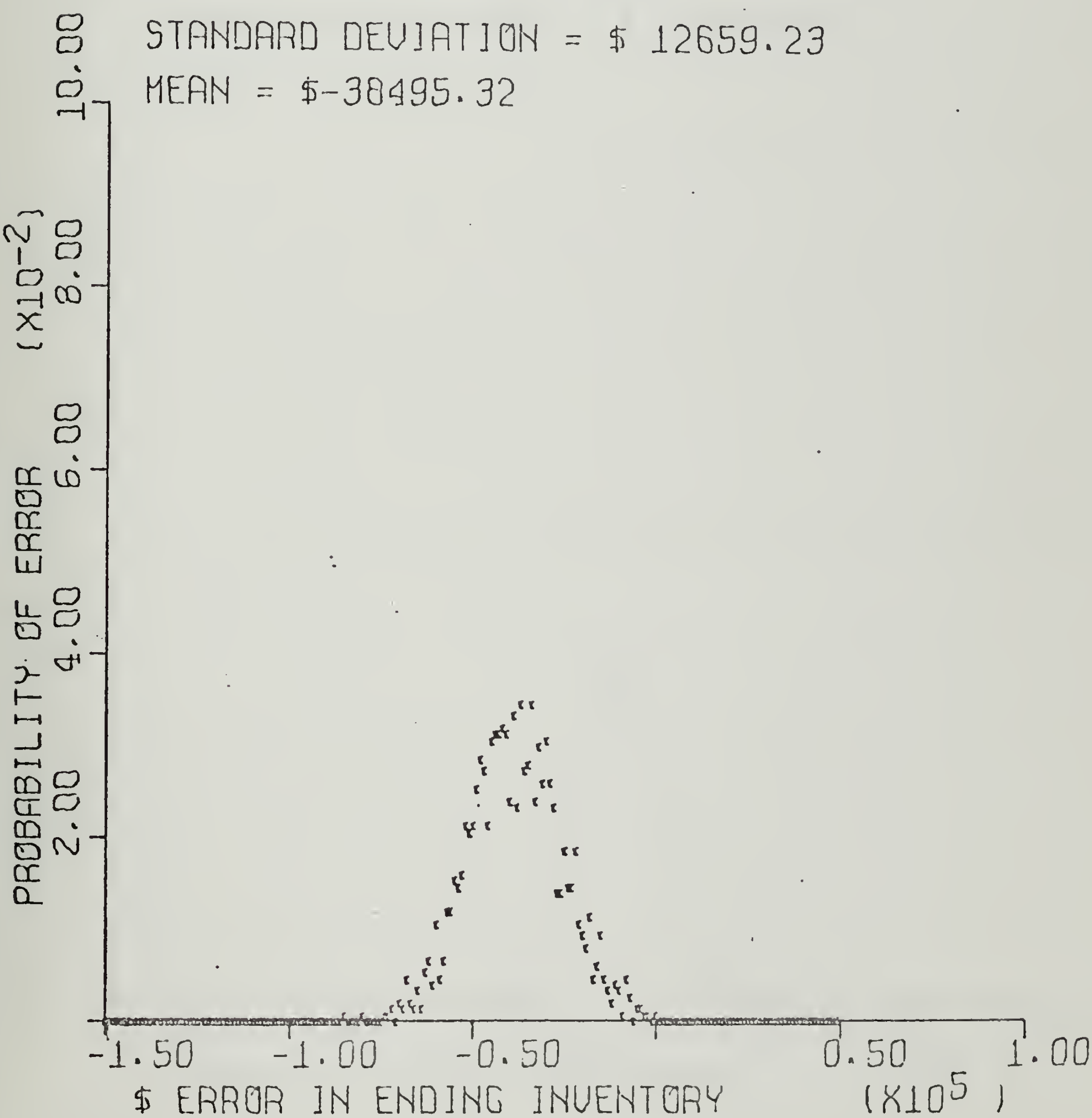


FIGURE C-18B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 10274.97
MEAN = $-12343.16

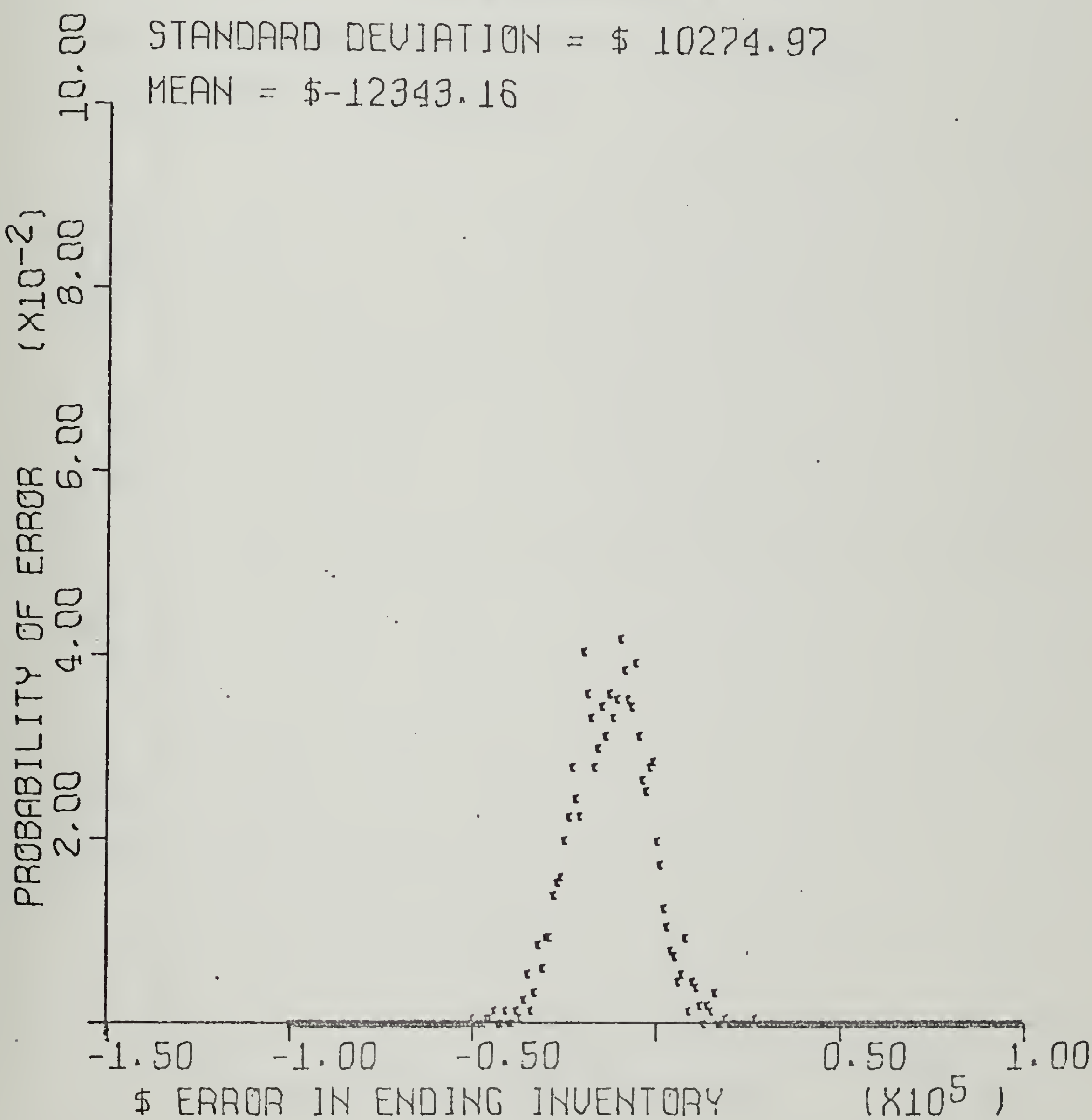


FIGURE C-18C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 6061.43
MEAN = $-20261.33

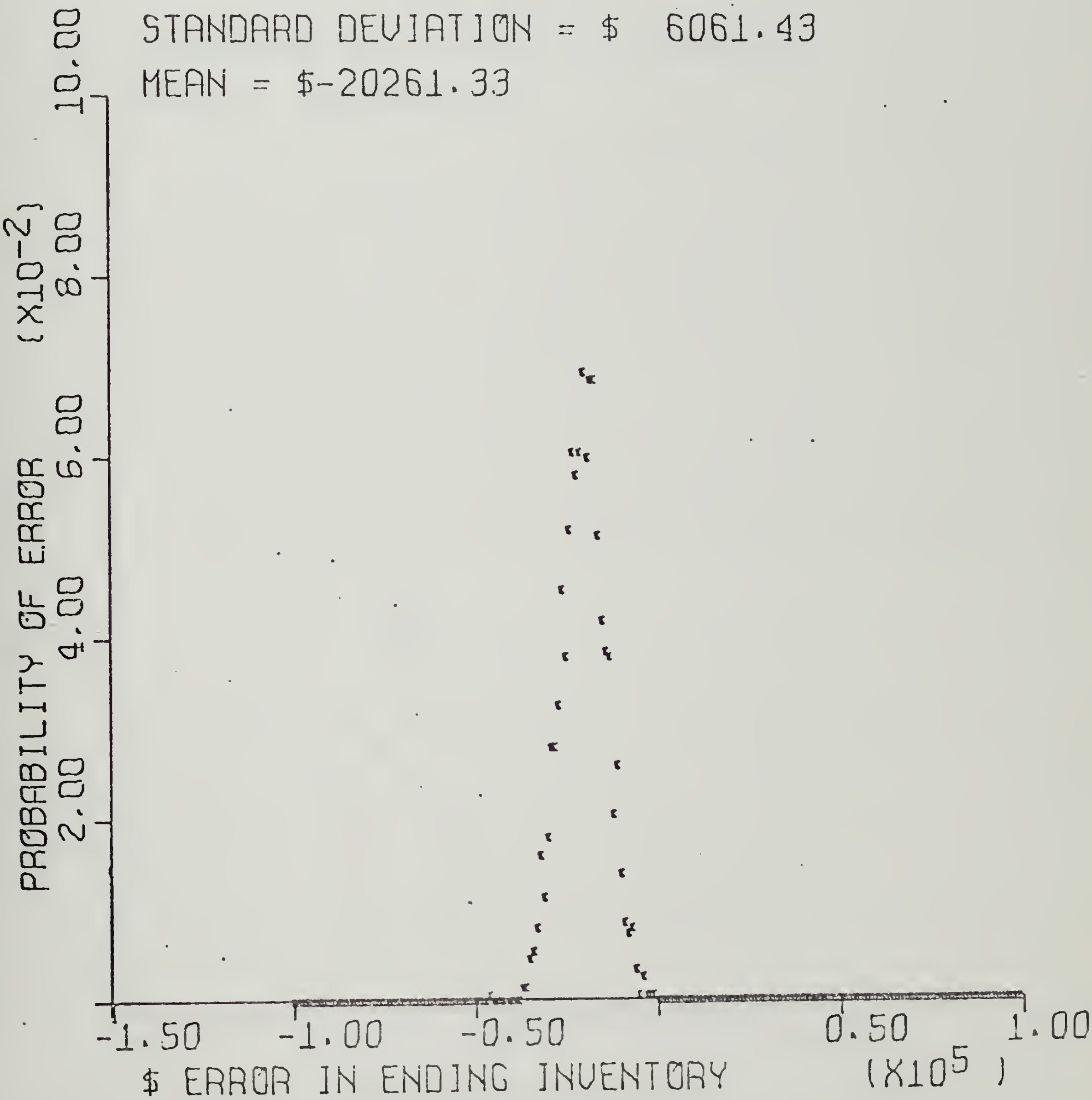


FIGURE C-18D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 9459.67
MEAN = $-70089.75

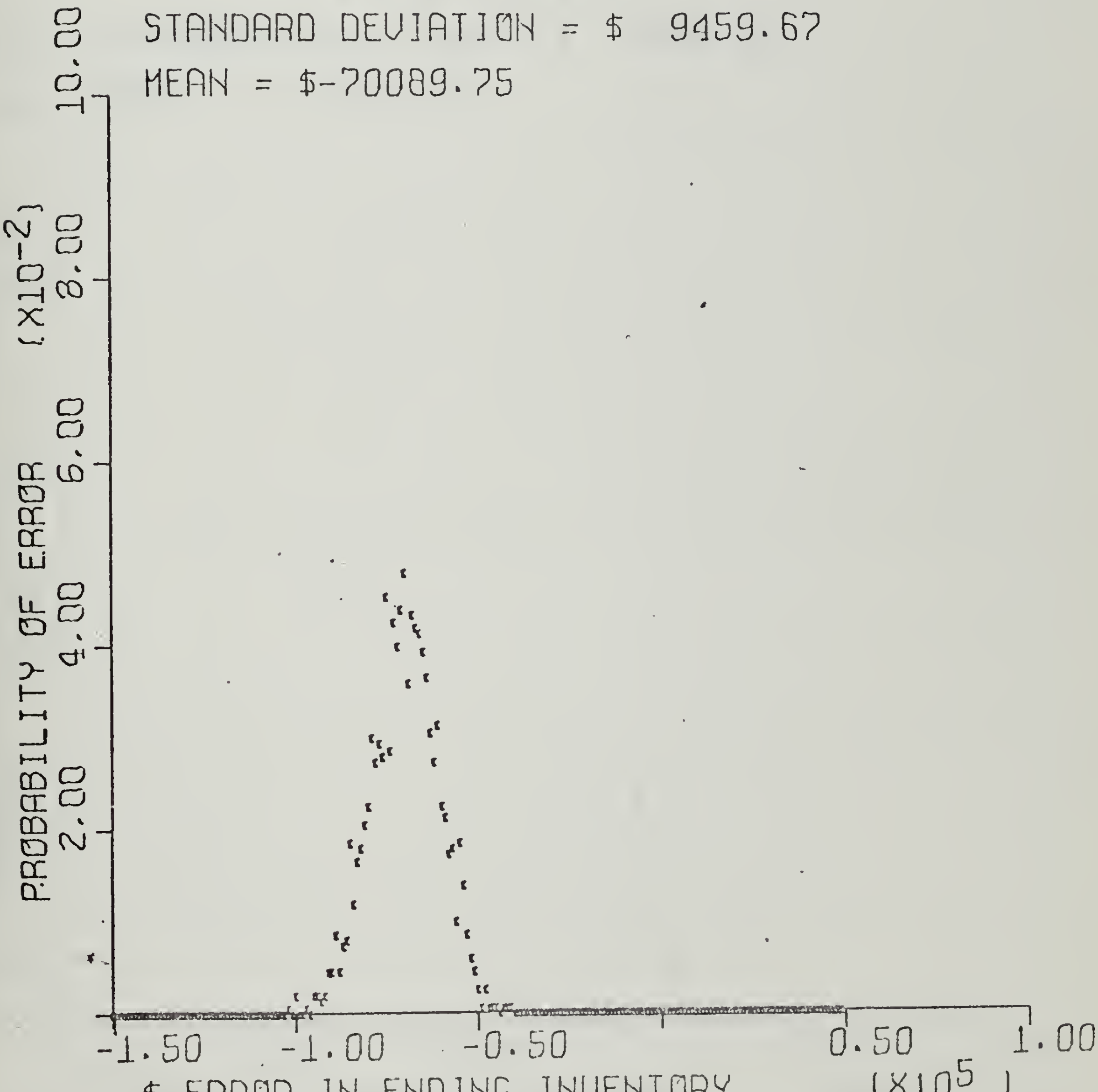


FIGURE C-19A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 3983.62
MEAN = $ 8660.01

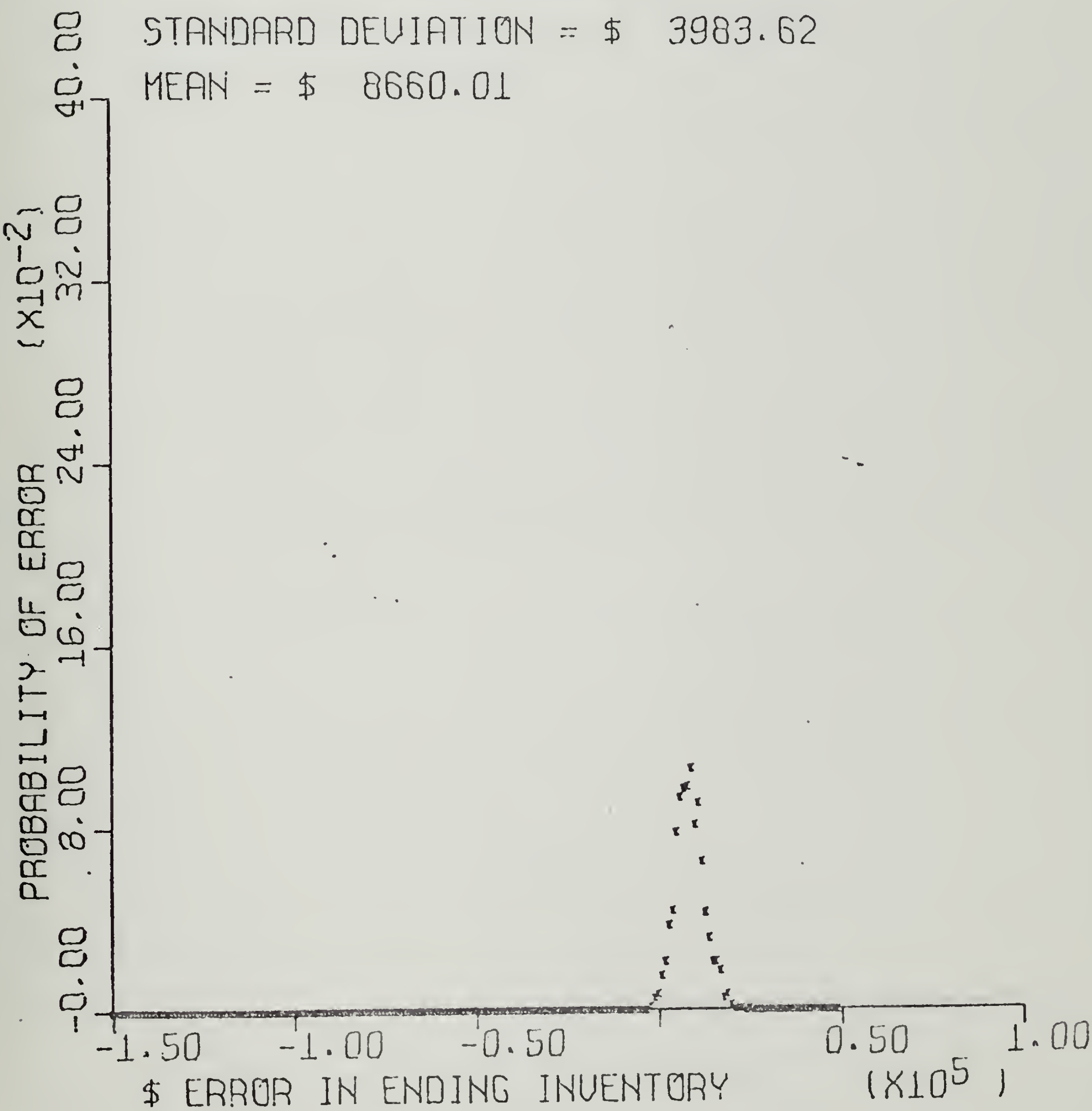


FIGURE C-19B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 3770.79
MEAN = $-11965.50

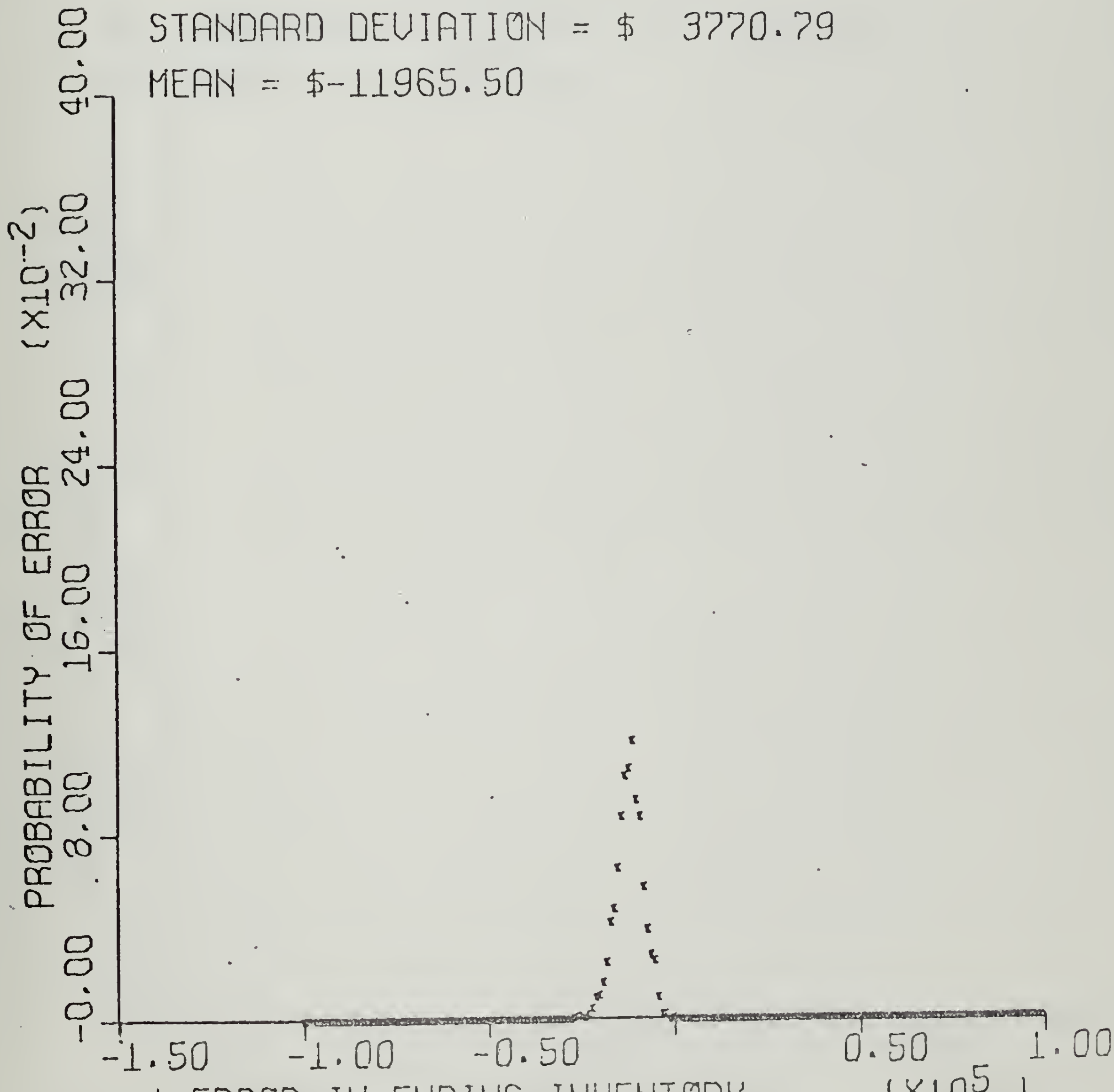


FIGURE C-19C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS; TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 1145.46
MEAN = $ -1795.99

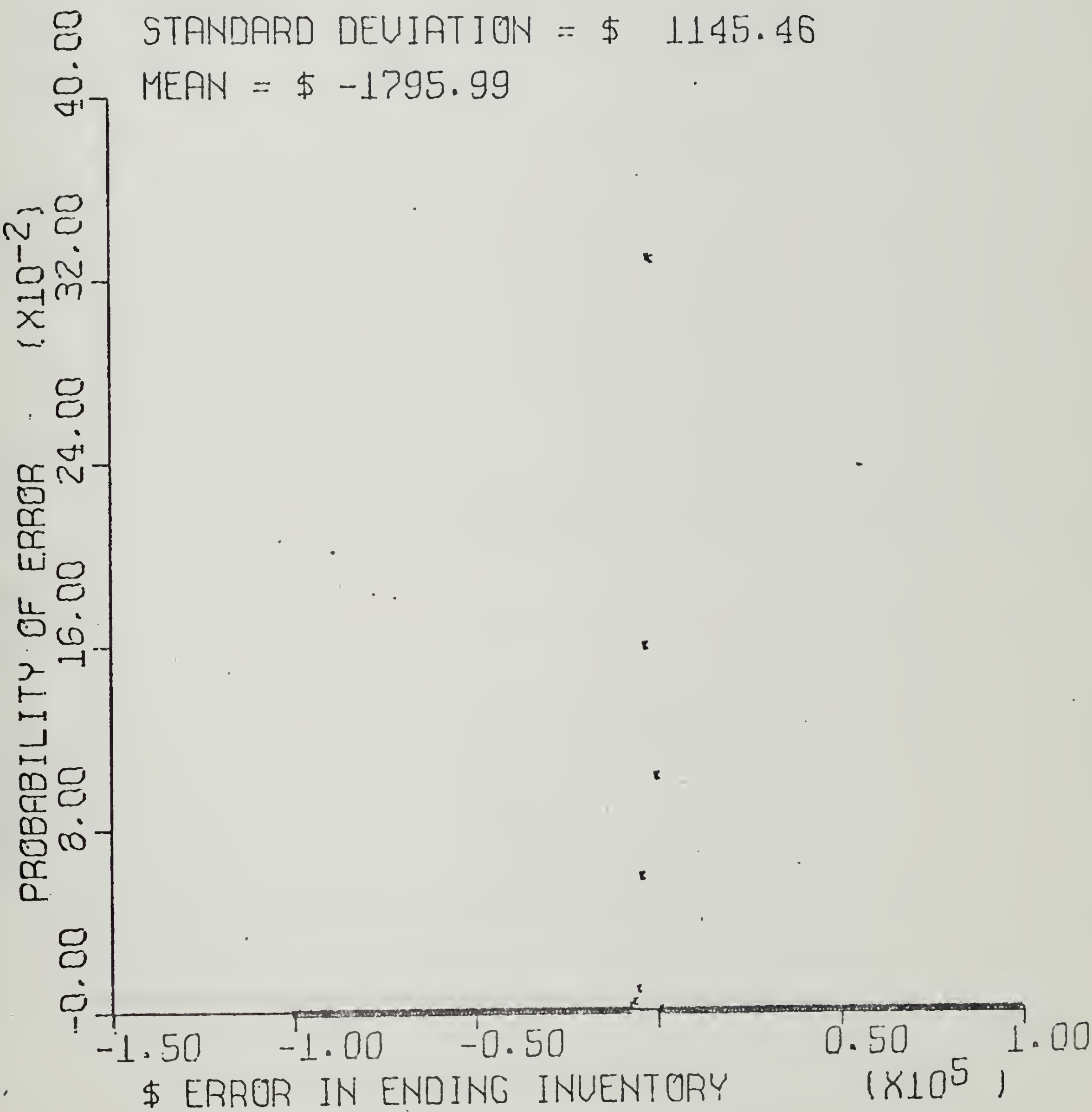


FIGURE C-19D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 1754.64
MEAN = $ -4092.75

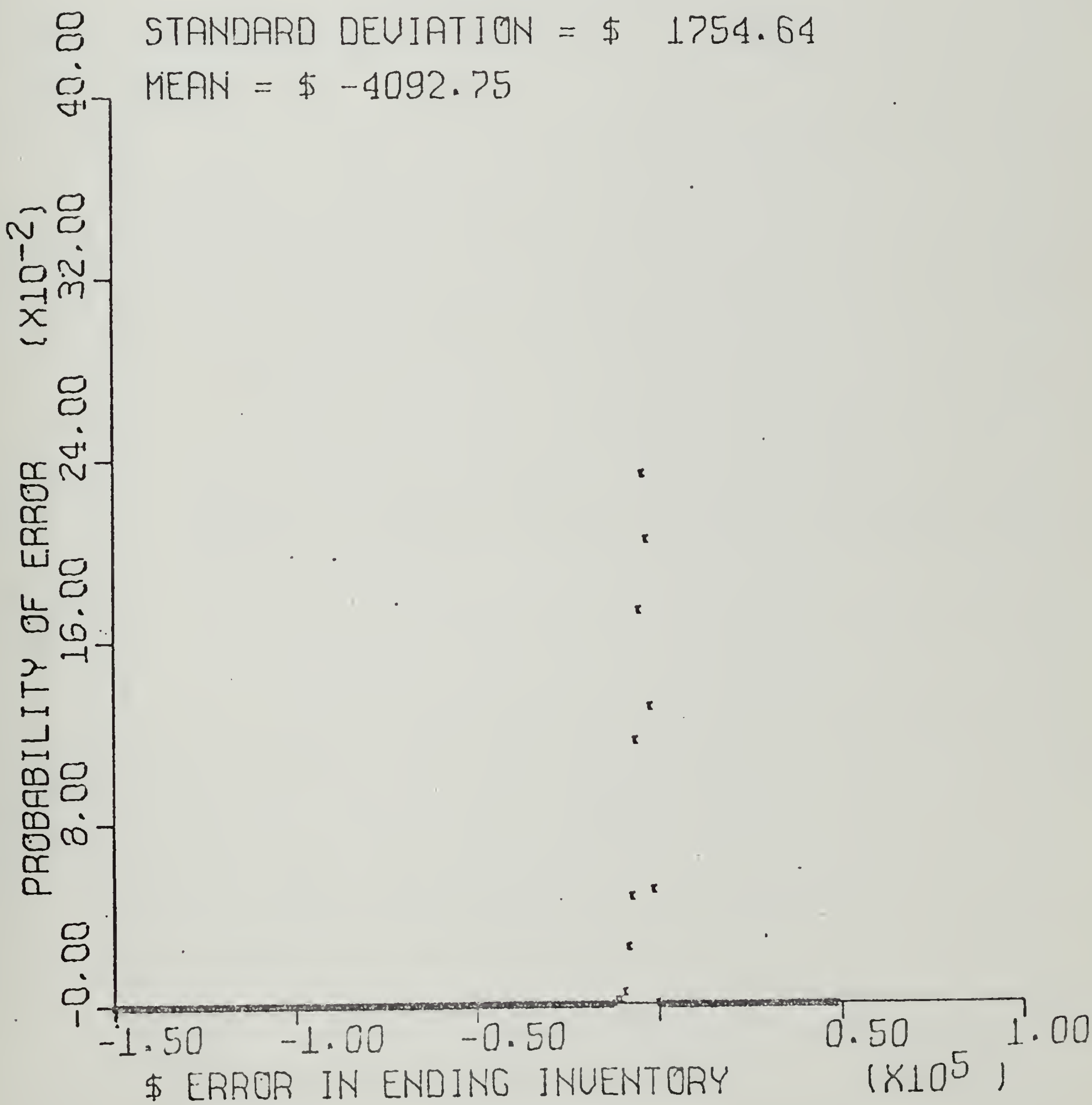


FIGURE C-20A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 0.0
MEAN = $ 0.0

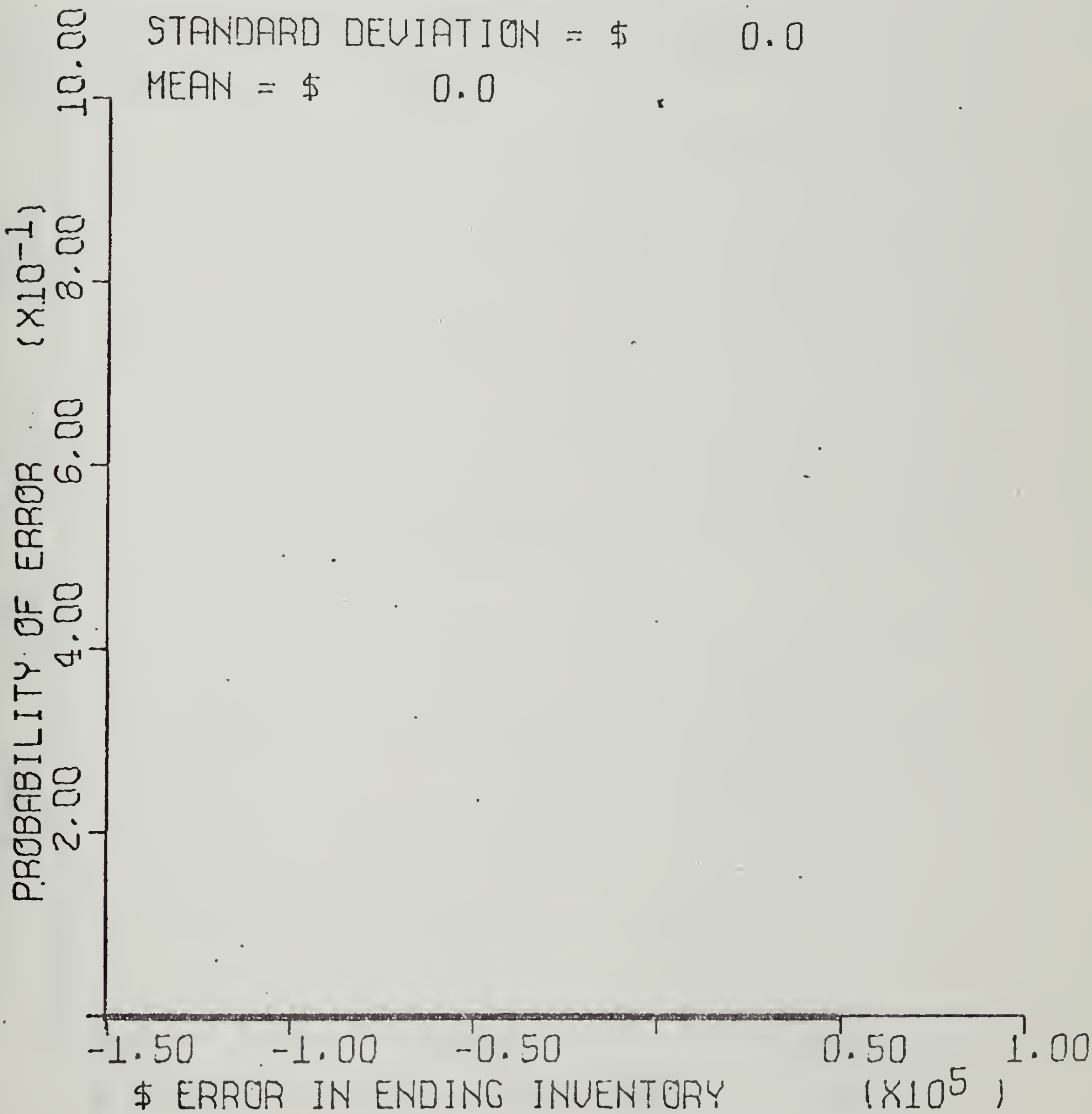


FIGURE C-20B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 0.0
MEAN = $ 0.0

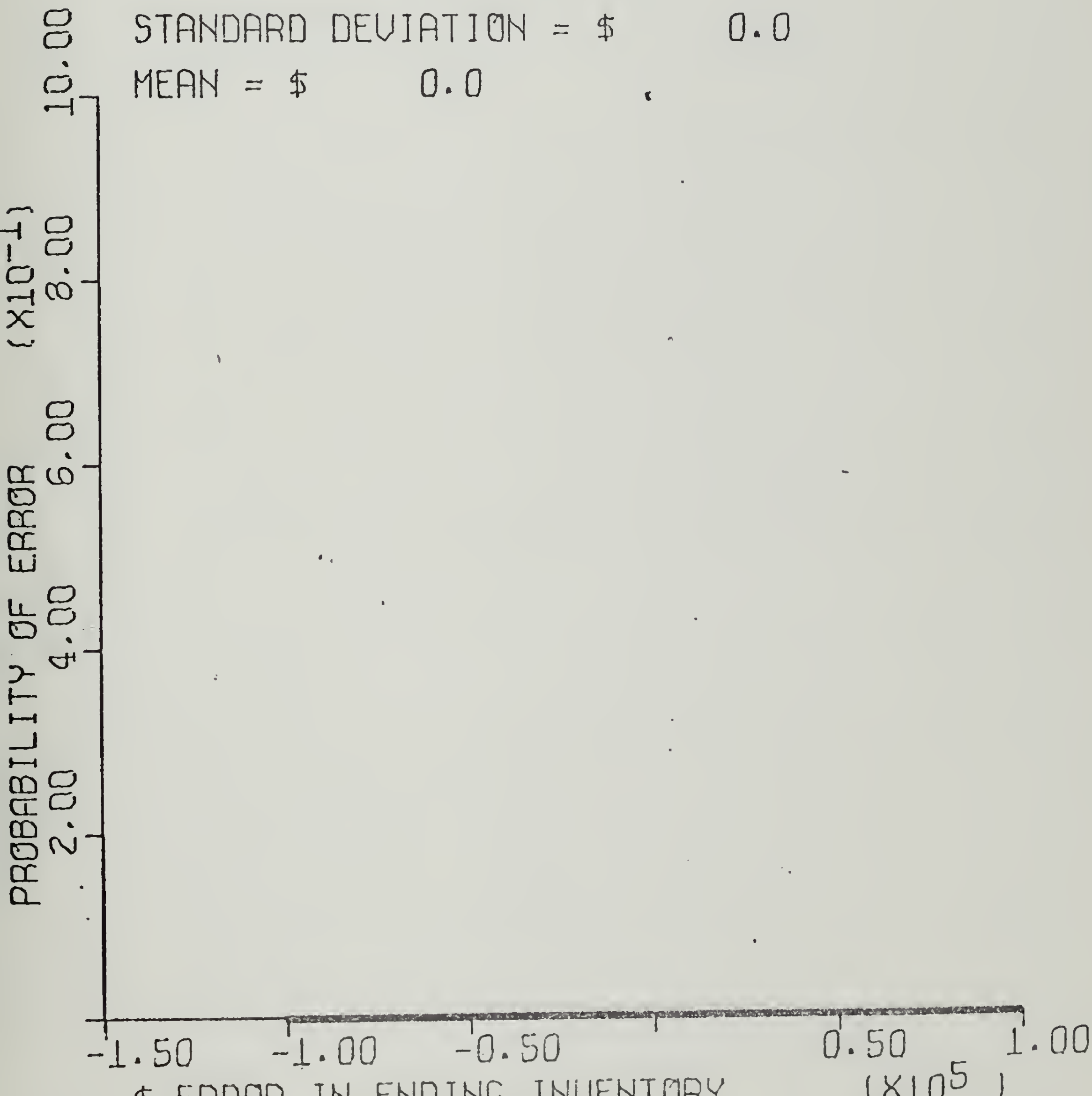


FIGURE C-20C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 0.0
MEAN = $ 0.0

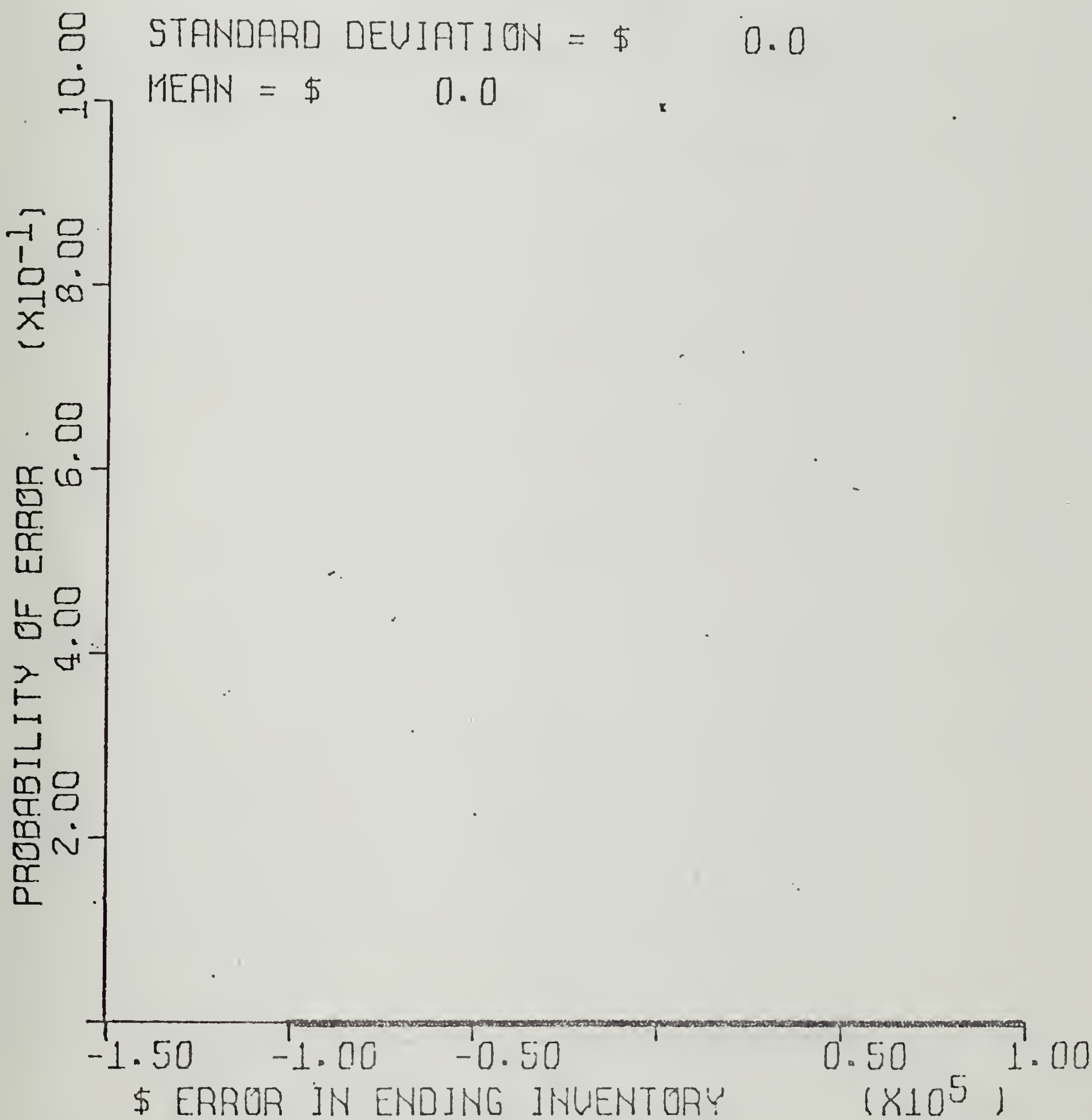


FIGURE C-20D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 0.0
MEAN = $ 0.0

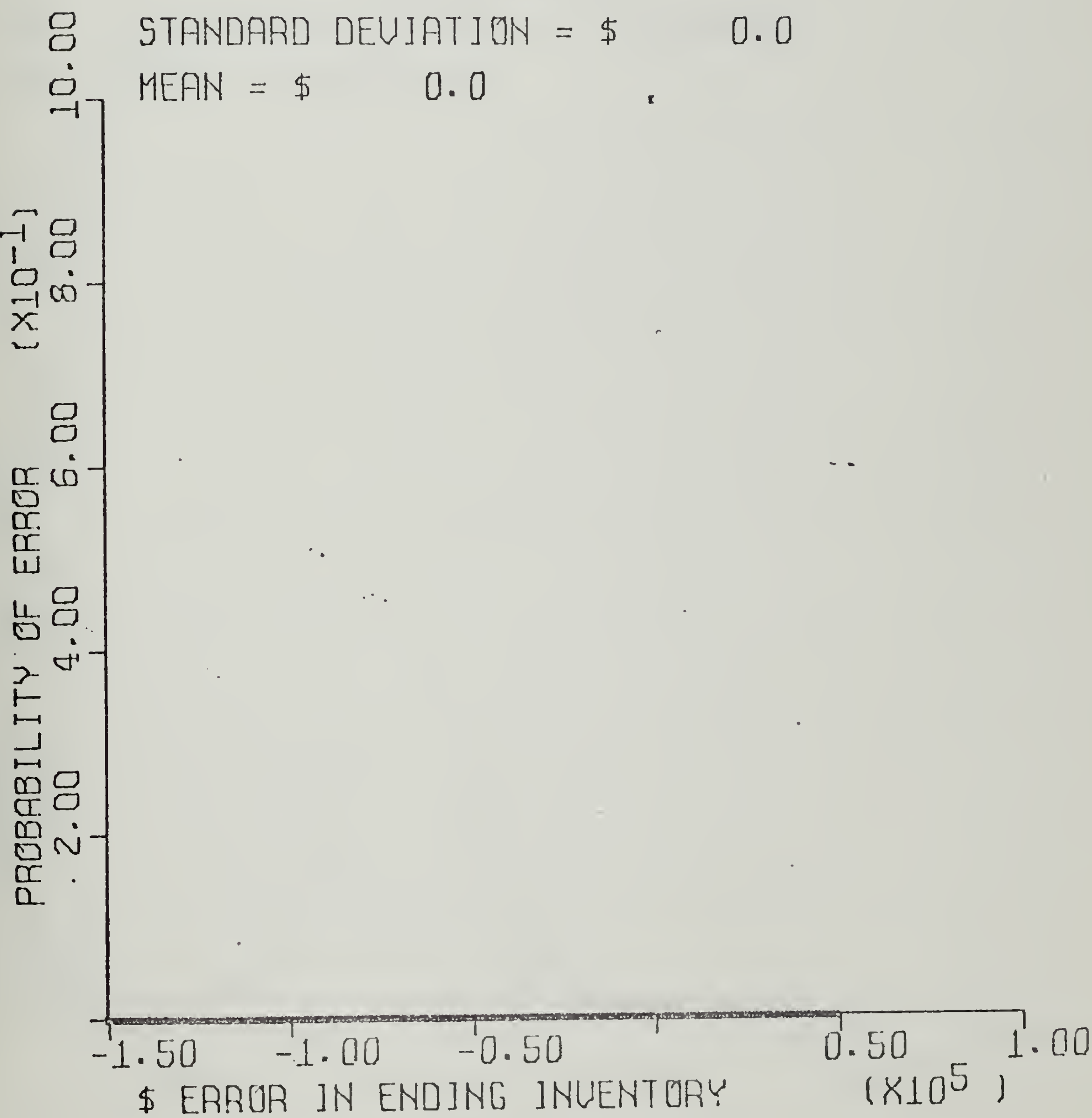


FIGURE C-21A

PROBABILITY OF DOLLAR ERROR IN
ENDING RAW MATERIAL INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: WEIGH-COUNT--10 UNITS

* * * * * * *

STANDARD DEVIATION = $ 16264.39
MEAN = $-61664.45

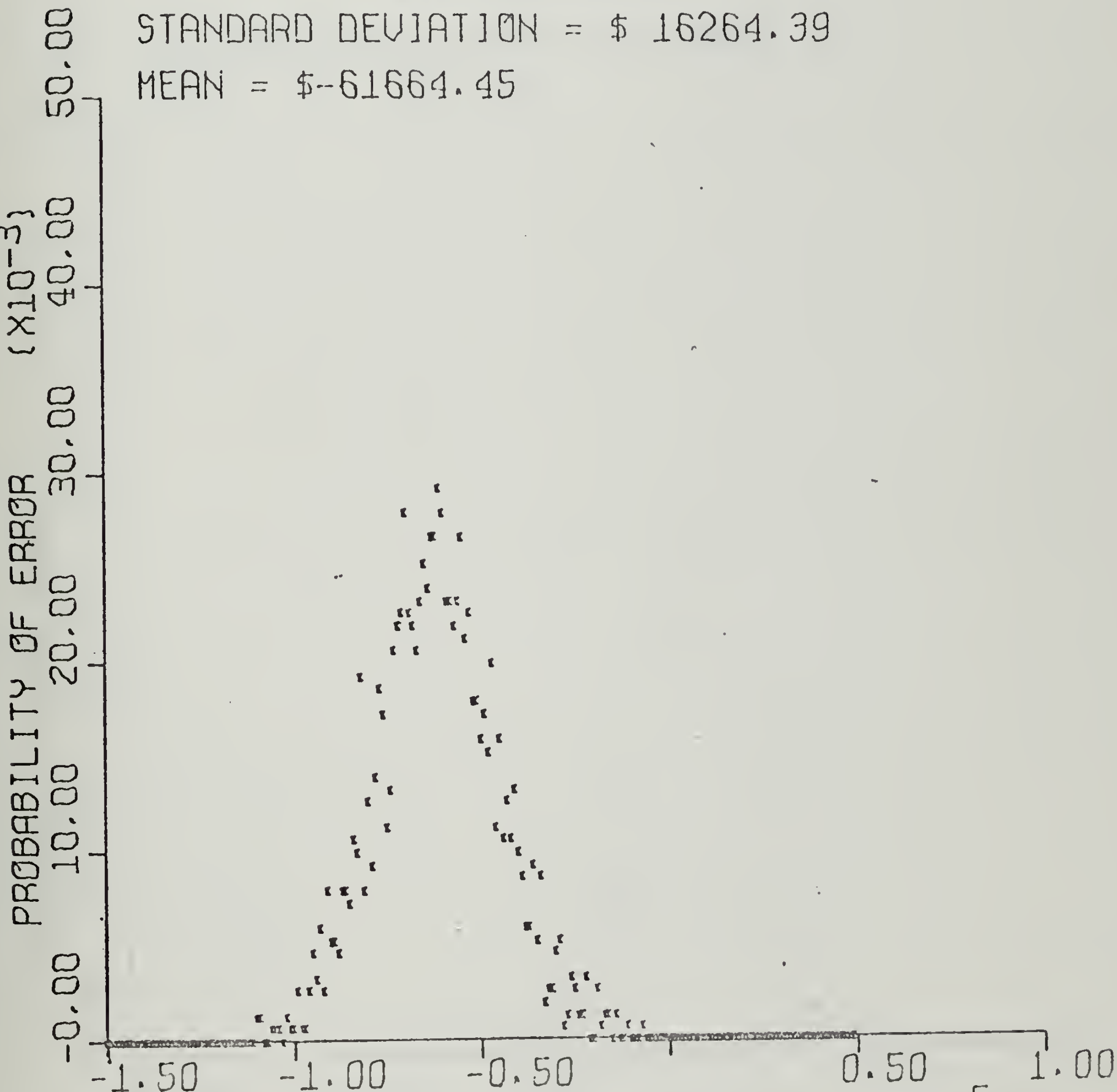


FIGURE C-21B

PROBABILITY OF DOLLAR ERROR IN
ENDING WORK-IN-PROCESS-INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS; WEIGH-COUNT--10 UNITS

* * * * * * *

STANDARD DEVIATION = $ 14884.41
MEAN = $ 1387.98

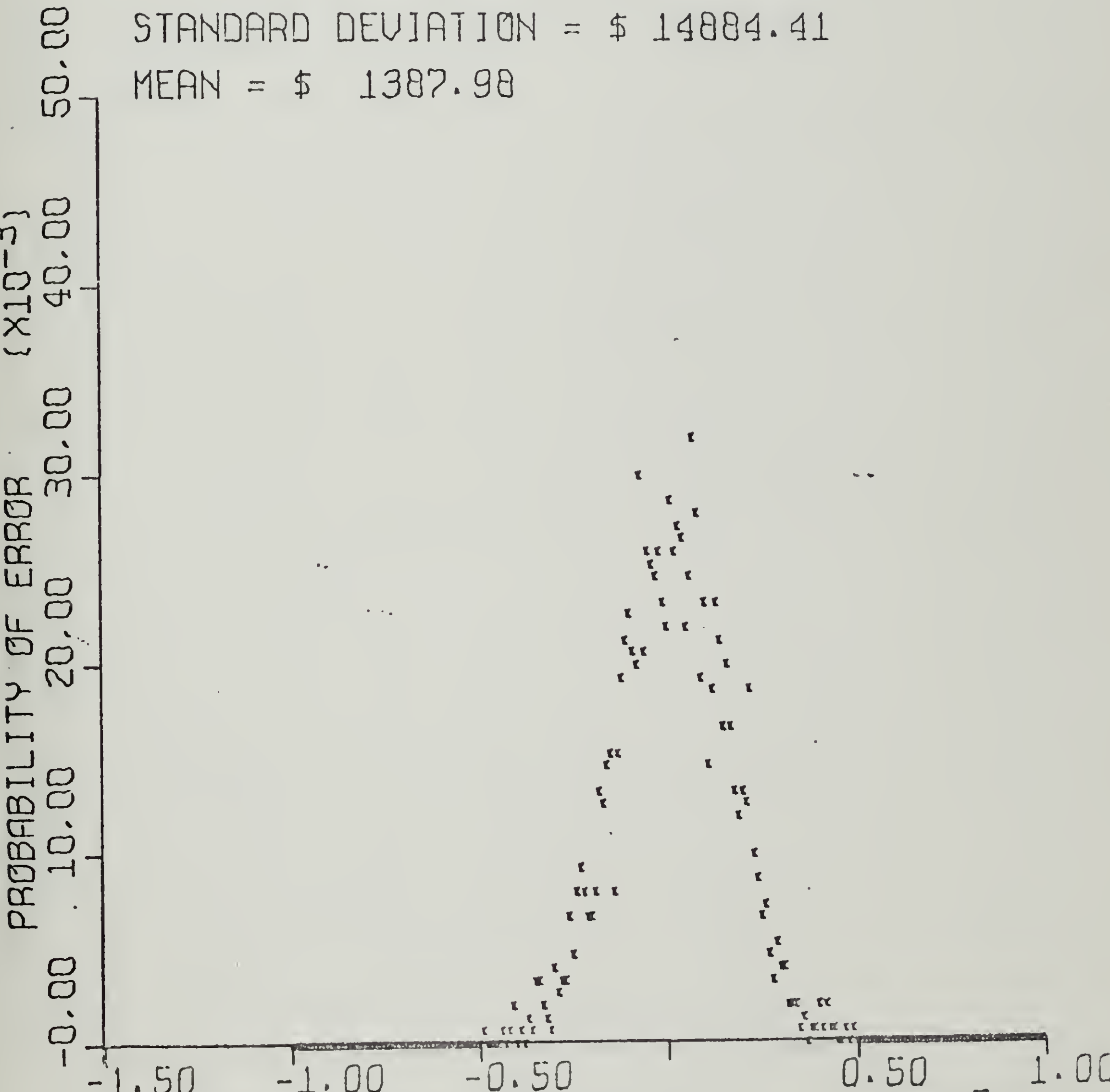


FIGURE C-21C

PROBABILITY OF DOLLAR ERROR IN
ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: WEIGH-COUNT--10 UNITS

* * * * * * *

STANDARD DEVIATION = $ 9848.30
MEAN = $ -510.59

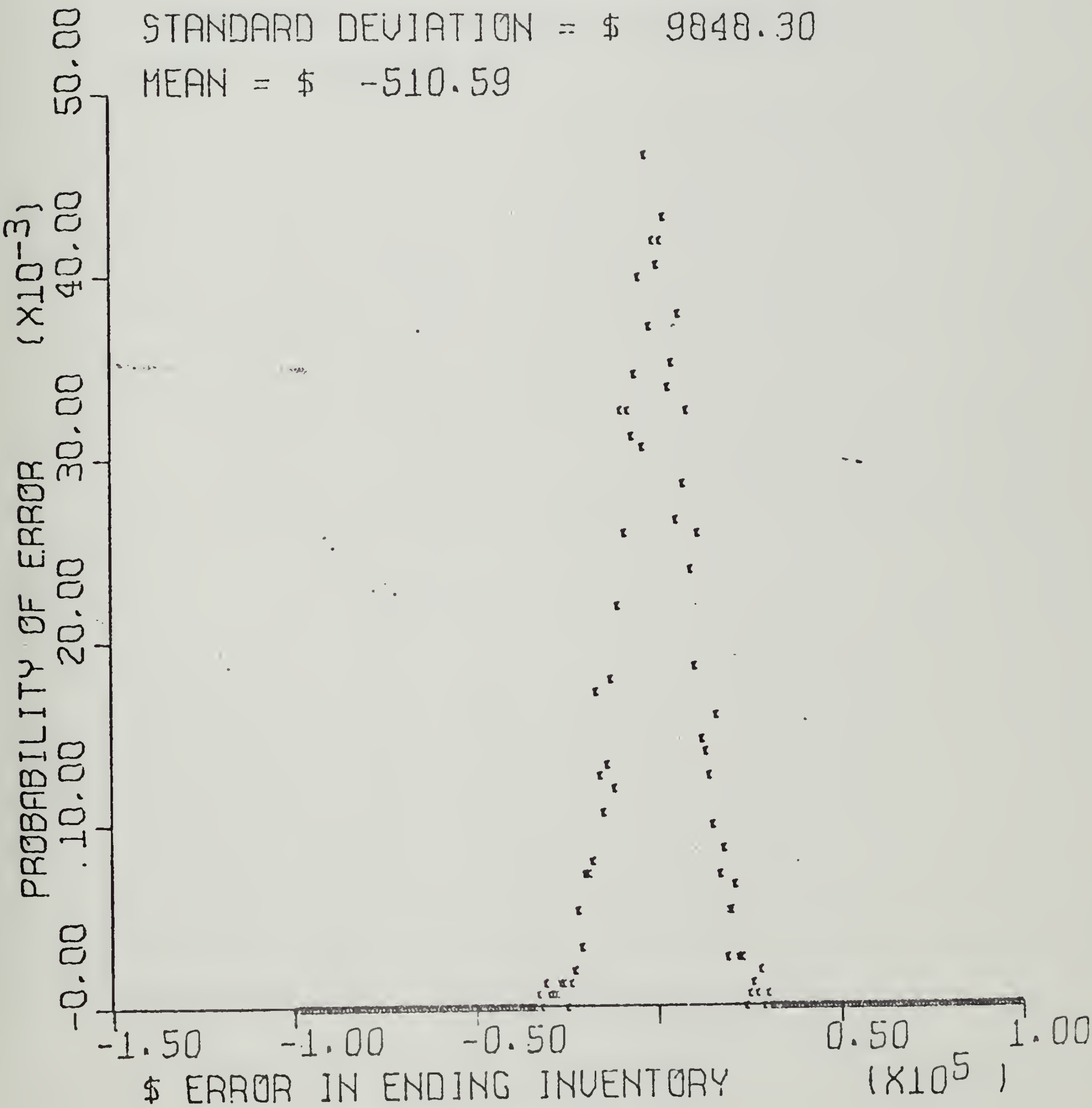


FIGURE C-21D

PROBABILITY OF DOLLAR ERROR IN
ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS; WEIGH-COUNT--10 UNITS

* * * * * * *

STANDARD DEVIATION = $ 12086.76
MEAN = $-59796.07

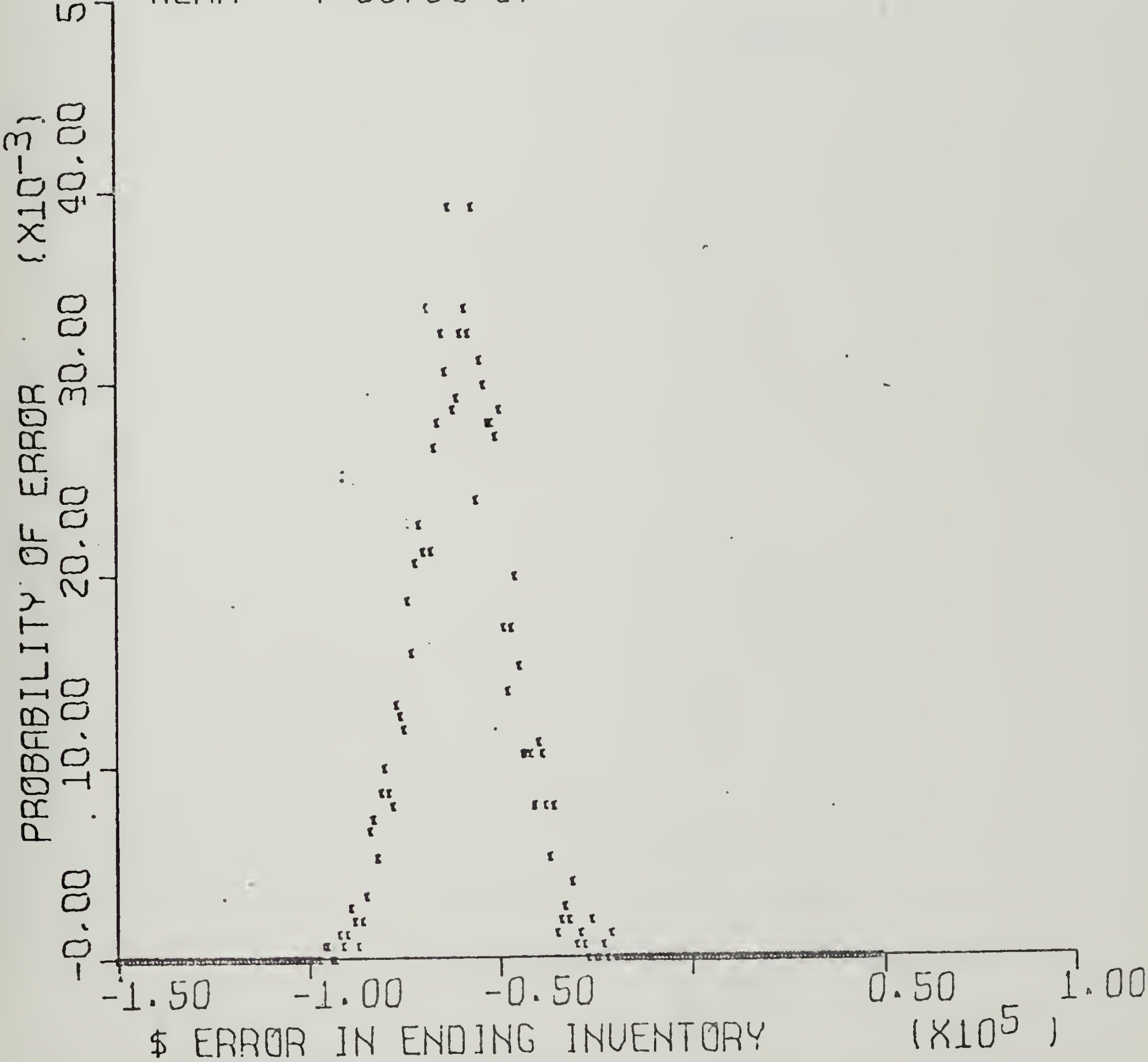


FIGURE C-22A

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL

* * * * * * *

STANDARD DEVIATION = $ 10131.43
MEAN = $102557.88

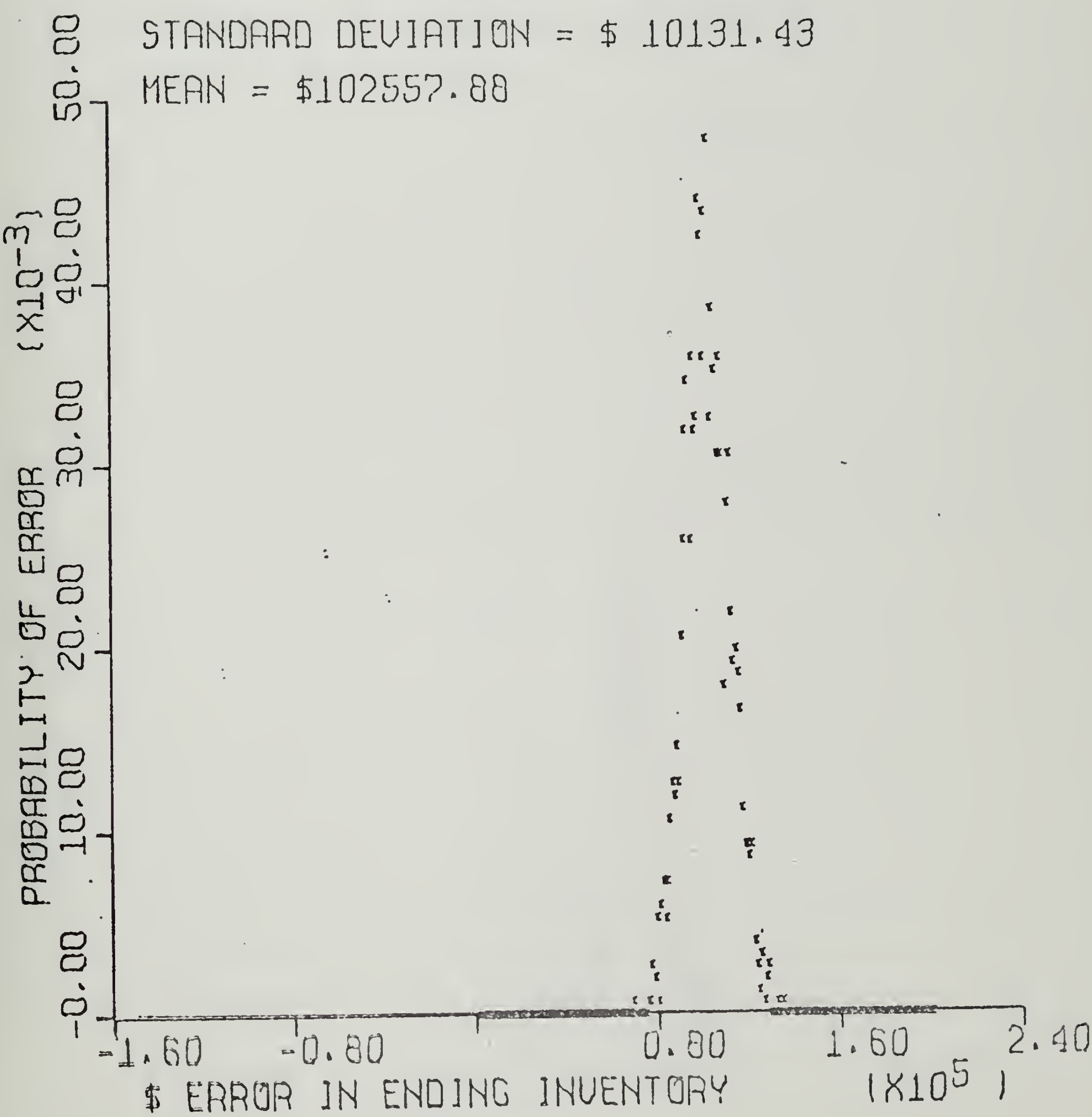


FIGURE C-22B

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL

* * * * * * *

STANDARD DEVIATION = $ 21269.58
MEAN = $381032.31

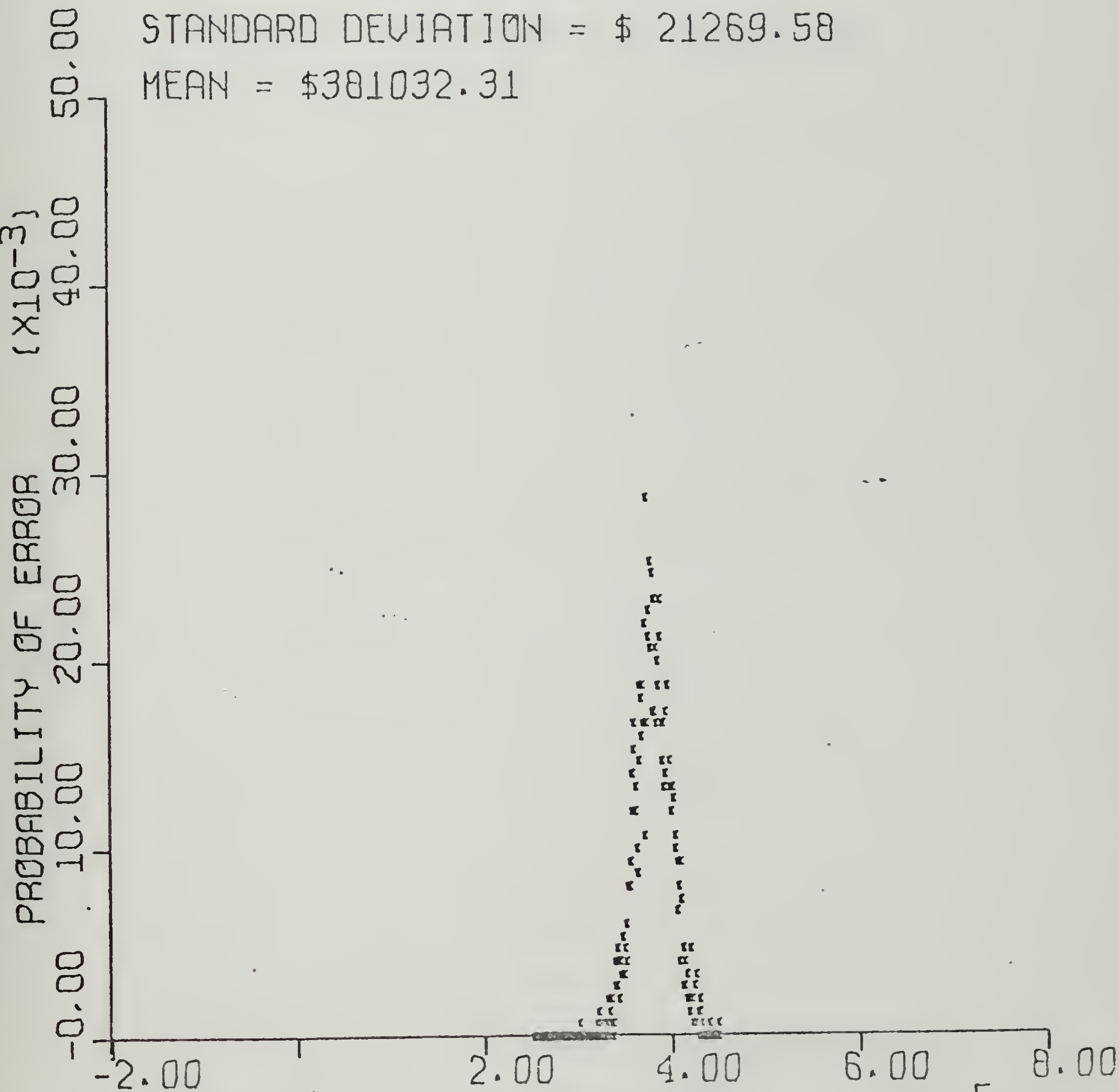


FIGURE C-23A

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 8664.38
MEAN = $ 73252.25

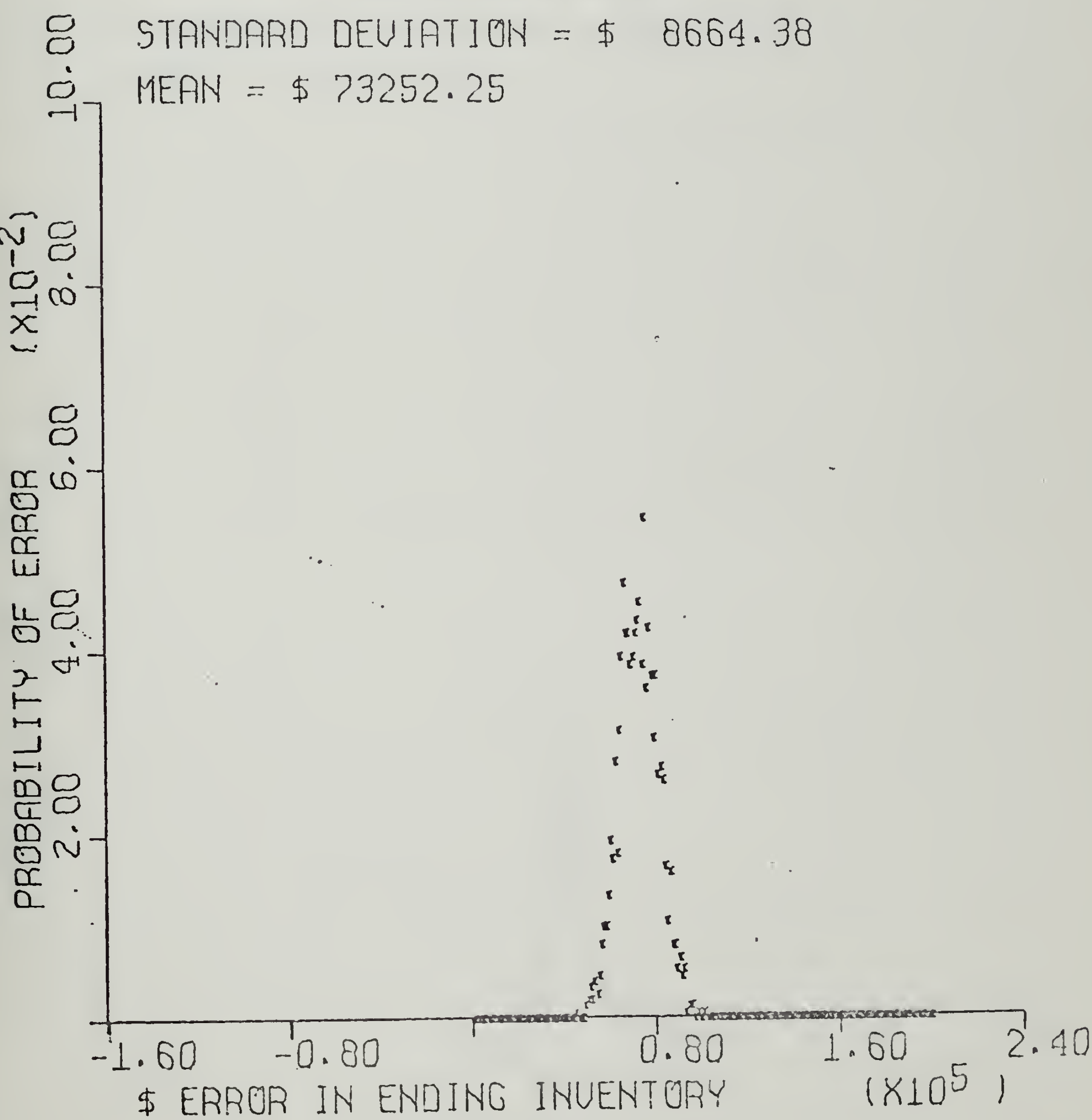


FIGURE C-23B

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $3000

* * * * * * *

STANDARD DEVIATION = $ 19078.44
MEAN = $315788.81

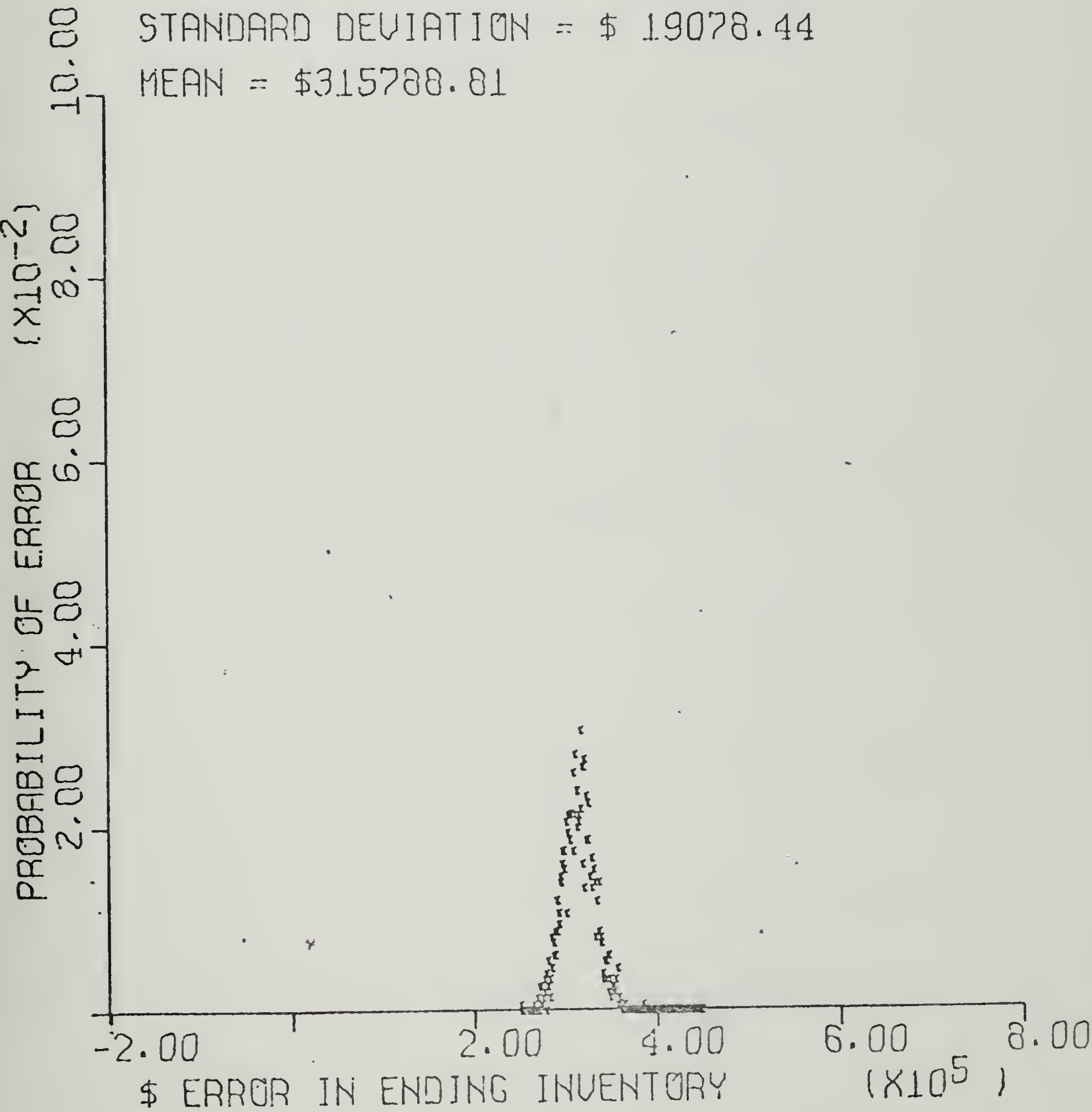


FIGURE C-24A

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 6099.07
MEAN = $ 38189.53

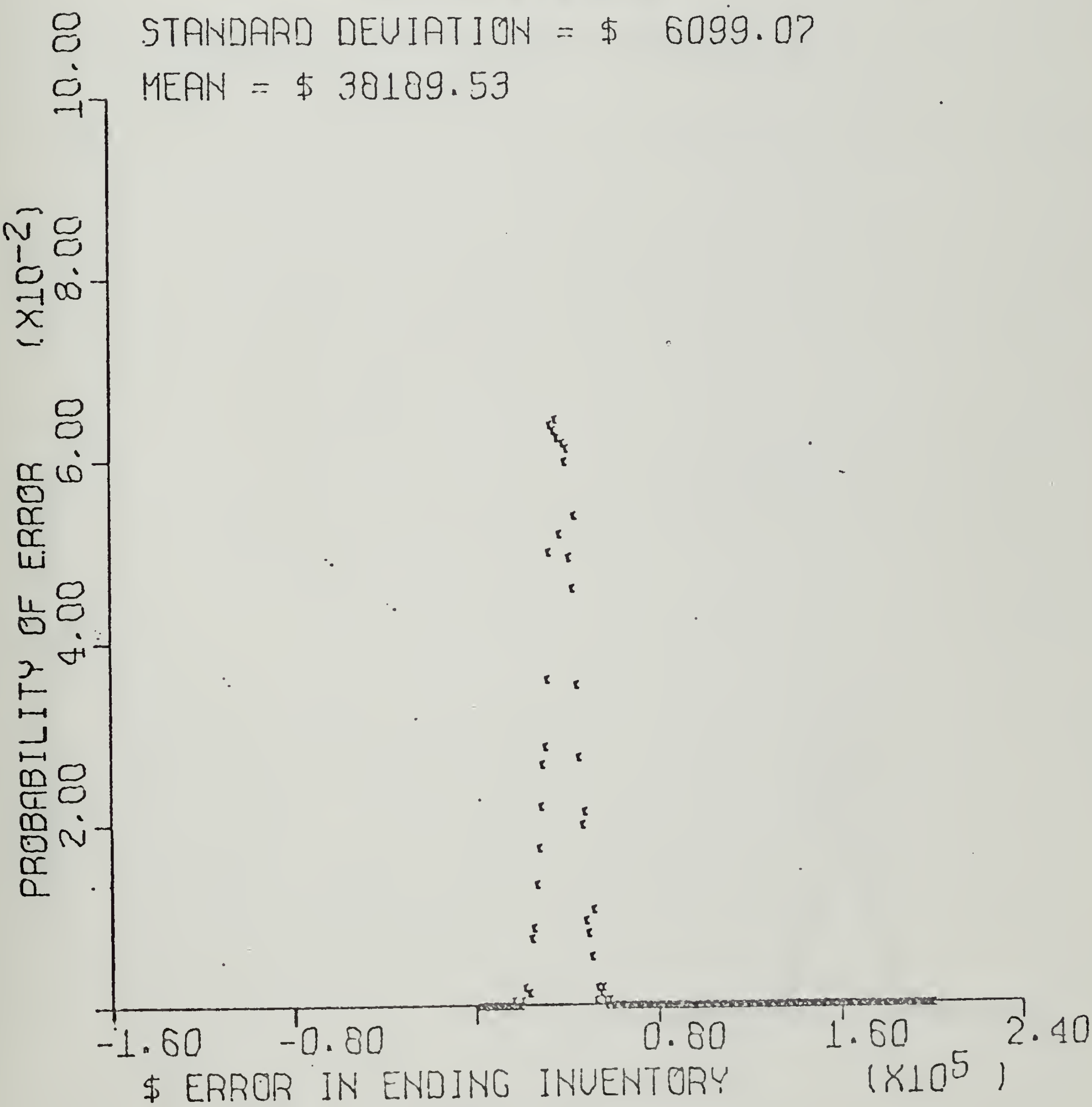


FIGURE C-24B

PROBABILITY OF ABSOLUTE DOLLAR ERROR IN ENDING COMBINED INVENTORY.

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL CONTROLS; TRANSACTIONS(PRICING & UNIT COUNT) IN RAW MATERIALS, WORK-IN-PROCESS AND FINISHED GOODS CORRECTED IF > $2000

* * * * * * *

STANDARD DEVIATION = $ 14493.42

MEAN = $196738.31

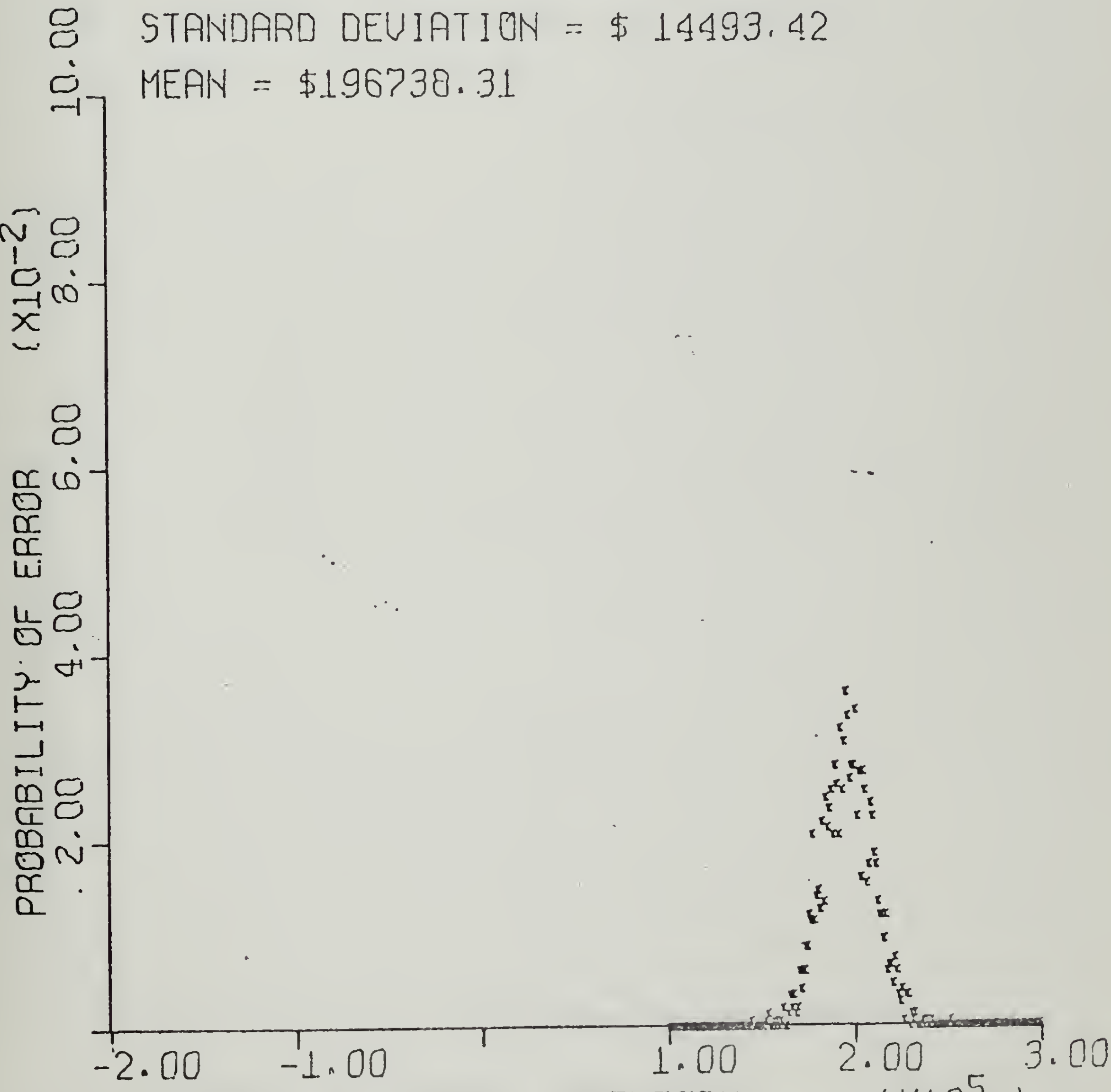


FIGURE C-25A

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 943.27
MEAN = $ 1722.68

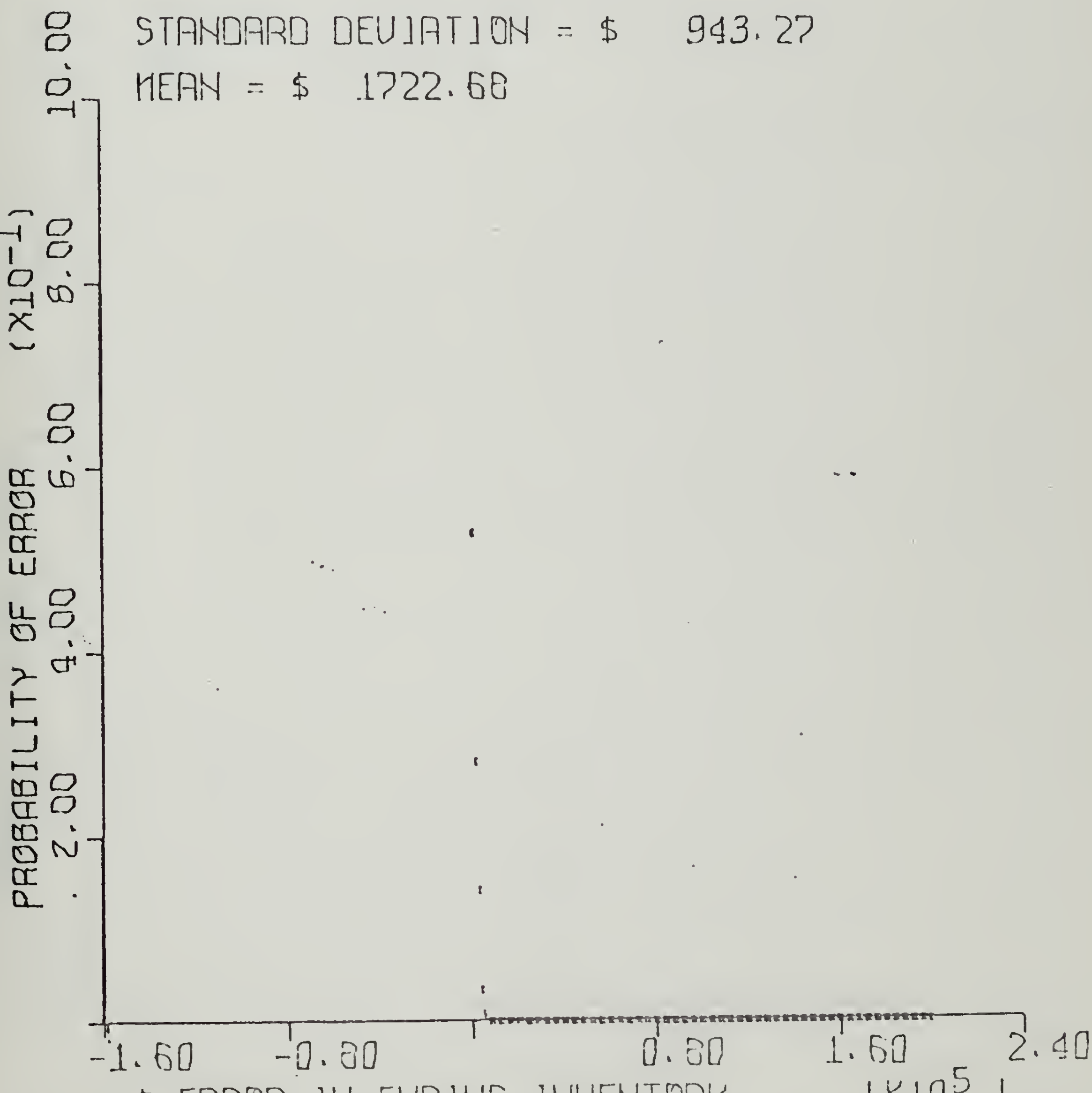


FIGURE C-25B

PROBABILITY OF ABSOLUTE DOLLAR ERROR IN ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT COUNT) IN RAW MATERIALS, WORK-IN-PROCESS AND FINISHED GOODS CORRECTED IF > $1000

* * * * * * *

STANDARD DEVIATION = $ 4191.14
MEAN = $ 36750.39

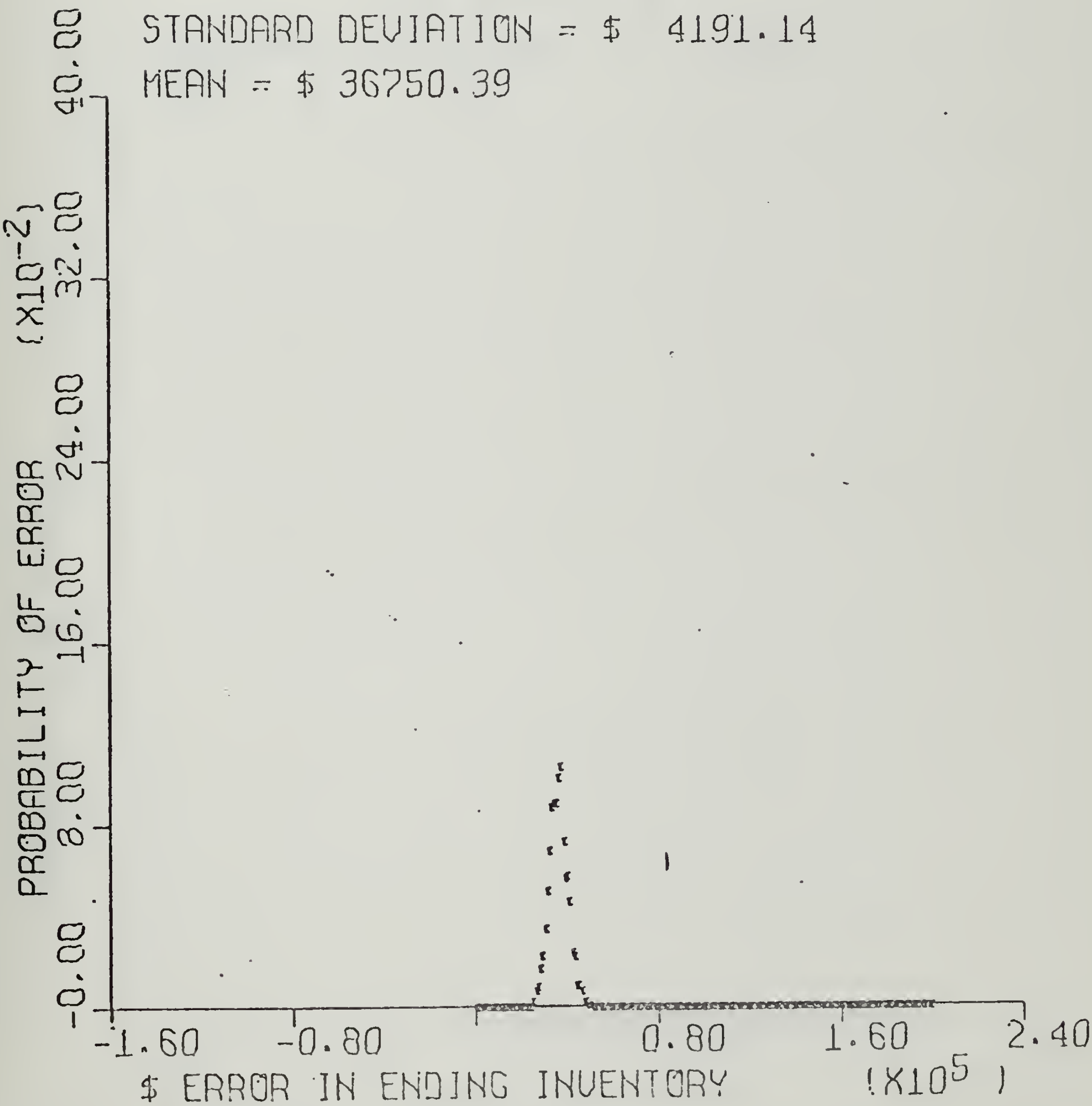


FIGURE C-26A

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 0.0
MEAN = $ 0.0

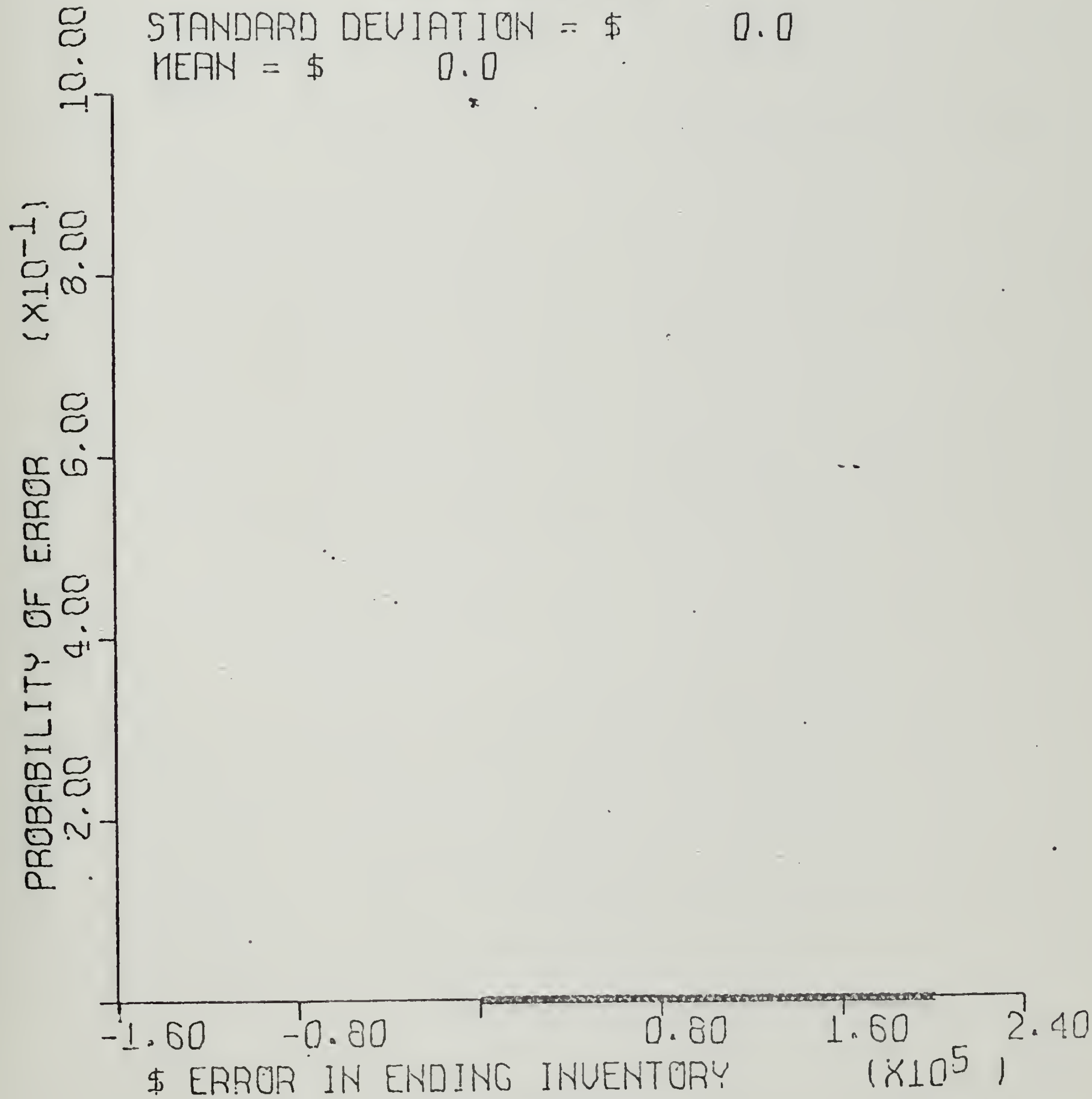


FIGURE C-26B

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
CONTROLS: TRANSACTIONS(PRICING & UNIT
COUNT) IN RAW MATERIALS, WORK-IN-PROCESS
AND FINISHED GOODS CORRECTED IF > $0000

* * * * * * *

STANDARD DEVIATION = $ 0.0
MEAN = $ 0.0

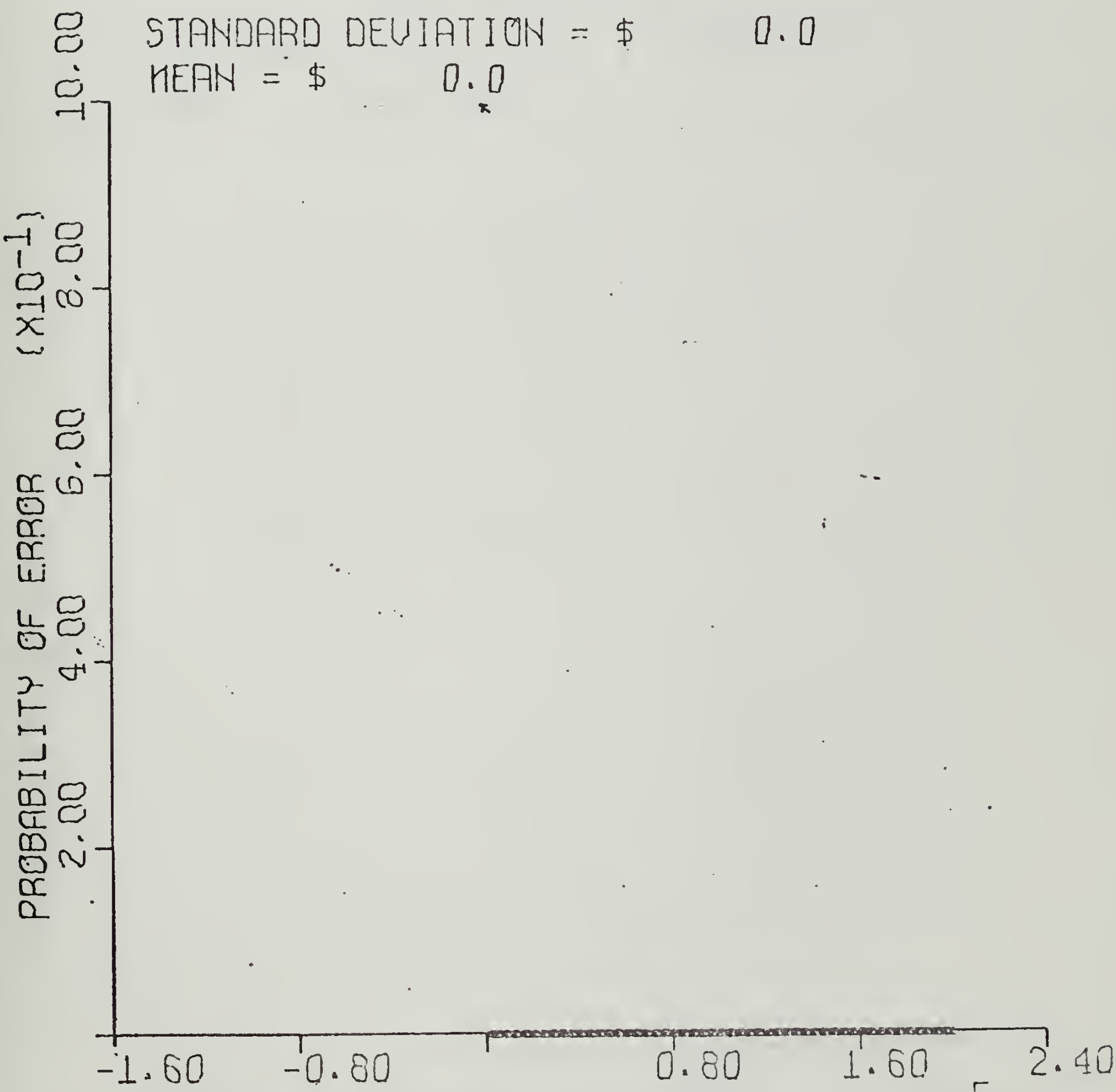


FIGURE C-27A

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING FINISHED GOODS INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 4.5 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 7042.53
MEAN = $ 51311.18

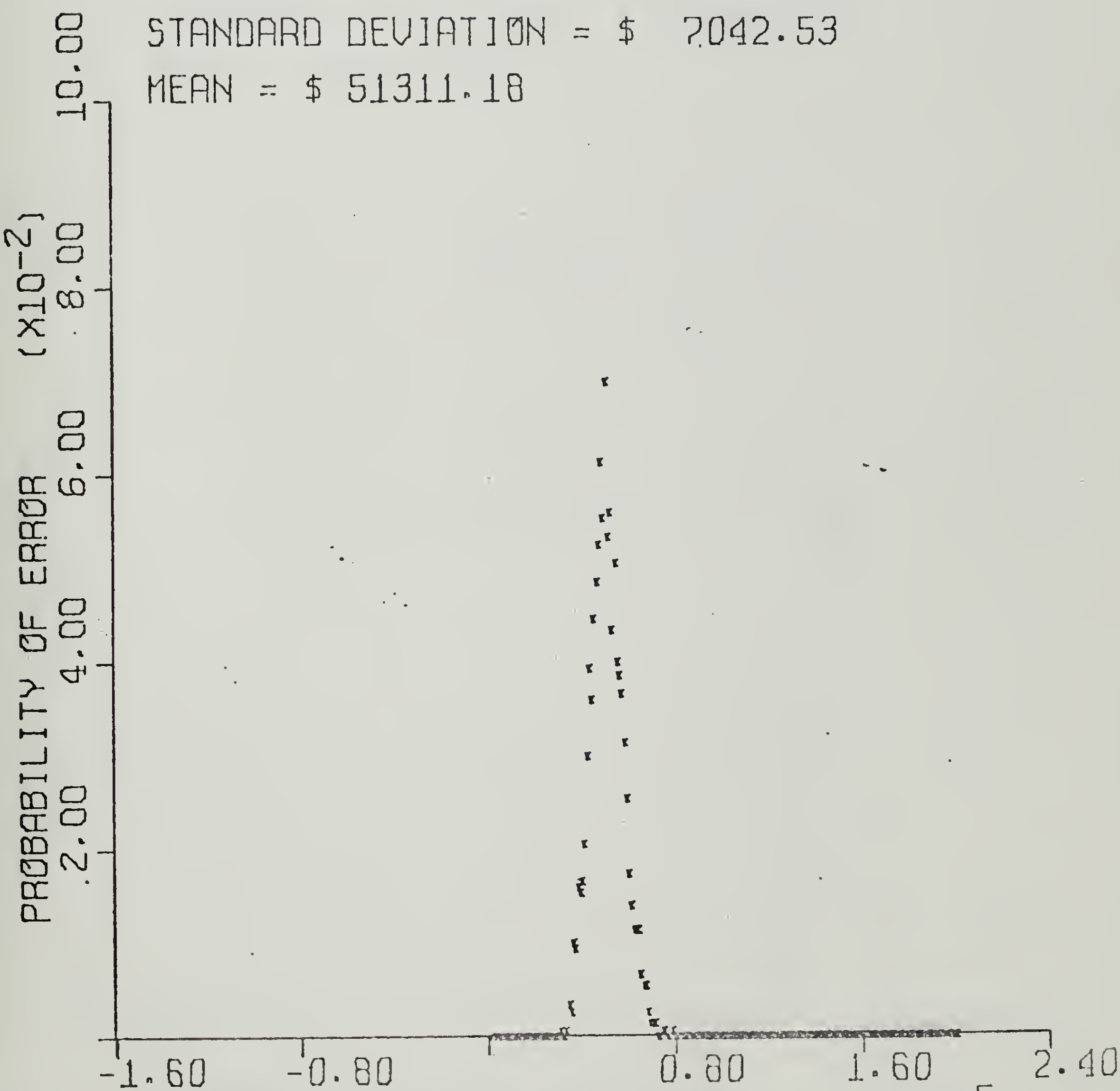


FIGURE C-27B

PROBABILITY OF ABSOLUTE DOLLAR
ERROR IN ENDING COMBINED INVENTORY

* * * * * * *

RAW MATL/PRODN ORDER DISTRIBUTION NORMAL
ACTIVITY LEVEL 4.5 MONTHS

* * * * * * *

STANDARD DEVIATION = $ 13903.04
MEAN = $190762.31

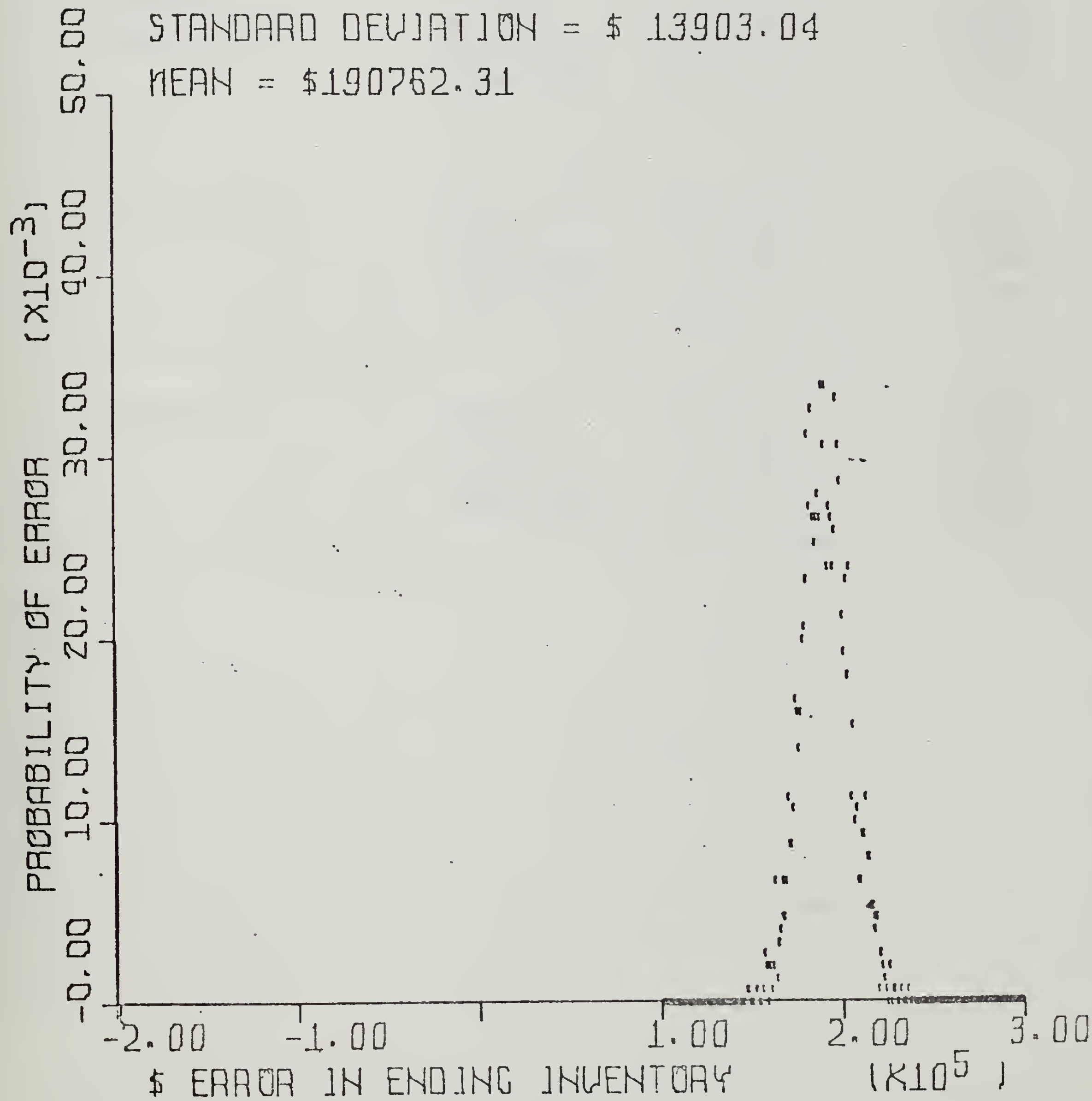


FIGURE D-1

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE DOLLAR ERROR IN ENDING INVENTORIES DUE TO CHANGES IN THE DISTRIBUTION OF RAW MATERIAL SHIPMENTS AND PRODUCTION ORDERS.

DISTRIBUTION OF RAW MATERIAL AND PRODUCTION ORDERS	ENDING INVENTORY	MEAN ($)	STANDARD DEVIATION ($)
NORMAL	RAW MAT'L	-61,664	16,264
(BASE CASE)	W-I-P	1,383	14,895
	FIN GOODS	20,688	10,153
	COMBINED	-38,596	11,969
EXPONENTIAL	RAW MAT'L	-60,894	22,402
	W-I-P	591	18,766
	FIN GOODS	7,088	12,356
	COMBINED	-52,214	17,343
UNIFORM	RAW MAT'L	-60,291	15,680
	W-I-P	164	14,360
	FIN GOODS	22,604	10,016
	COMBINED	-36,505	11,869

FIGURE D-2

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORY WHEN THE MEAN OF THE DISTRIBUTION OF RAW MATERIAL SHIPMENTS AND PRODUCTION ORDERS IS DOUBLED.

RAW MATERIAL AND PRODUCTION ORDERS

	ORDER MEAN					
	RAW MATERIAL		PRODUCT			
DISTRIBUTION	1&3	2&4	1-4	ENDING INVENTORY	MEAN ($)	STANDARD DEVIATION ($)
NORMAL (BASE CASE)	200	180	150	RAW MAT'L	-61,664	16,264
				W-I-P	1,383	14,895
				FIN GOODS	20,688	10,153
				COMBINED	-38,596	11,969
NORMAL	400	360	300	RAW MAT'L	-62,487	23,355
				W-I-P	1,505	20,961
				FIN GOODS	- 1,205	13,694
				COMBINED	-61,209	17,766
EXPONENTIAL	200	180	150	RAW MAT'L	-60,894	22,402
				W-I-P	591	18,766
				FIN GOODS	7,088	12,356
				COMBINED	-52,214	17,343
EXPONENTIAL	400	180 360	300	RAW MAT'L	-61,542	31,998
				W-I-P	131	27,093
				FIN GOODS	- 876	17,196
				COMBINED	-61,344	24,446
UNIFORM	200	180	150	RAW MAT'L	-60,291	15,681
				W-I-P	164	14,360
				FIN GOODS	22,604	10,016
				COMBINED	-36,505	11,869
UNIFORM	400	360	300	RAW MAT'L	-61,916	22,371
				W-I-P	1,114	19,793
				FIN GOODS	- 2,399	13,218
				COMBINED	-62,193	17,456

FIGURE D-3

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES WHEN ACCOUNTING ACTIVITY IS CHANGED.

DISTRIBUTION OF RAW MATERIAL AND PRODUCTION ORDERS	ACCOUNTING ACTIVITY LEVEL	ENDING INVENTORY	MEAN ($)	STANDARD DEVIATION ($)
NORMAL (BASE CASE)	9 MOS.	RAW MAT'L	-61,664	16,264
		W-I-P	1,383	14,895
		FIN GOODS	20,688	10,153
		COMBINED	-38,596	11,969
NORMAL	18 MOS.	RAW MAT'L	-121,604	22,146
		W-I-P	1,072	20,353
		FIN GOODS	42,871	14,594
		COMBINED	- 76,653	17,066
NORMAL	4.5 MOS.	RAW MAT'L	- 31,057	11,665
		W-I-P	551	10,481
		FIN GOODS	10,007	7,071
		COMBINED	- 19,478	8,800

FIGURE D-4

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES WHEN ACCOUNTING CONTROLS (UNIT PRICING) ARE APPLIED TO TRANSACTIONS IN RAW MATERIAL RECEIPT AND TRANSFER TO WORK-IN-PROCESS.

DISTRIBUTION OF RAW MATERIAL AND PRODUCTION ORDERS	TRANSACTIONS CORRECTED	ENDING INVENTORY	MEAN ($)	STANDARD DEVIATION ($)
NORMAL (BASE CASE)	NONE	RAW MAT'L	-61,664	16,264
		W-I-P	1,383	14,895
		FIN GOODS	20,688	10,153
		COMBINED	-38,596	11,969
NORMAL	> $3000	RAW MAT'L	-70,440	15,198
		W-I-P	- 8,192	14,438
		FIN GOODS	20,688	10,153
		COMBINED	-56,947	11,087
NORMAL	> $2000	RAW MAT'L	-73,812	12,856
		W-I-P	-35,705	13,153
		FIN GOODS	20,688	10,153
		COMBINED	-87,846	9,505
NORMAL	> $1000	RAW MAT'L	-48,189	5,299
		W-I-P	- 9,009	10,770
		FIN GOODS	20,688	10,153
		COMBINED	-35,490	3,445
NORMAL	> $0	RAW MAT'L	-59,884	3,644
		W-I-P	5,247	10,103
		FIN GOODS	20,688	10,153
		COMBINED	-32,955	3,030

FIGURE D-5

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES WHEN ACCOUNTING CONTROLS (UNIT PRICING AND UNIT COUNT) ARE APPLIED TO TRANSACTIONS IN RAW MATERIAL RECEIPT AND TRANSFER TO WORK-IN-PROCESS.

DISTRIBUTION OF RAW MATERIAL AND PRODUCTION ORDERS	TRANSACTIONS CORRECTED	ENDING INVENTORY	MEAN ($)	STANDARD DEVIATION ($)
NORMAL (BASE CASE)	NONE	RAW MAT'L	-61,664	16,264
		W-I-P	1,383	14,895
		FIN GOODS	20,688	10,153
		COMBINED	-38,596	11,970
NORMAL	> $3000	RAW MAT'L	-61,956	15,182
		W-I-P	-11,882	14,446
		FIN GOODS	20,688	10,153
		COMBINED	-52,159	11,142
NORMAL	> $2000	RAW MAT'L	-38,495	12,659
		W-I-P	-47,117	13,150
		FIN GOODS	20,688	10,153
		COMBINED	-63,908	9,518
NORMAL	> $1000	RAW MAT'L	8,660	3,984
		W-I-P	-28,372	10,819
		FIN GOODS	20,688	10,153
		COMBINED	1,970	2,106
NORMAL	> $0	RAW MAT'L	0	0
		W-I-P	-15,615	10,147
		FIN GOODS	20,688	10,153
		COMBINED	5,568	11,176

FIGURE D-6

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES WHEN ACCOUNTING CONTROLS (UNIT PRICING AND UNIT COUNT) ARE APPLIED TO TRANSACTIONS IN RAW MATERIALS, WORK-IN-PROCESS AND FINISHED GOODS.

DISTRIBUTION OF RAW MATERIAL AND PRODUCTION ORDERS	TRANSACTIONS CORRECTED	ENDING INVENTORY	MEAN ($)	STANDARD DEVIATION ($)
NORMAL (BASE CASE)	NONE	RAW MAT'L	-61,664	16,264
		W-I-P	1,383	14,895
		FIN GOODS	20,688	10,153
		COMBINED	-38,596	11,969
NORMAL	> $3000	RAW MAT'L	-61,955	15,184
		W-I-P	10,756	13,285
		FIN GOODS	- 8,585	8,554
		COMBINED	-58,784	11,104
NORMAL	> $2000	RAW MAT'L	-38,495	12,659
		W-I-P	-12,343	10,275
		FIN GOODS	-20,261	6,061
		COMBINED	-70,090	9,460
NORMAL	> $1000	RAW MAT'L	8,660	3,984
		W-I-P	-11,965	3,771
		FIN GOODS	- 1,796	1,145
		COMBINED	- 4,093	1,755
NORMAL	> $0	RAW MAT'L	0	0
		W-I-P	0	0
		FIN GOODS	0	0
		COMBINED	0	0

FIGURE D-7

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR IN ENDING INVENTORIES WHEN WEIGH-COUNT CONTROL ON TRANSFER OF COMPLETED PRODUCTS TO FINISHED GOODS IS TIGHTENED.

DISTRIBUTION OF RAW MATERIAL AND PRODUCTION ORDERS	PRODUCTION ORDER SIZE CORRECTED IF WEIGH-COUNT ERROR	ENDING INVENTORY	MEAN ($)	STANDARD DEVIATION ($)
NORMAL (BASE CASE)	> 20 UNITS	RAW MAT'L	-61,664	16,264
		W-I-P	1,383	14,895
		FIN GOODS	20,688	10,153
		COMBINED	-38,596	11,969
NORMAL	> 10 UNITS	RAW MAT'L	-61,664	16,264
		W-I-P	1,388	14,884
		FIN GOODS	- 511	9,848
		COMBINED	-59,796	12,087

FIGURE D-8

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF NET DOLLAR ERROR AND ABSOLUTE DOLLAR ERROR IN FINISHED GOODS AND COMBINED ENDING INVENTORIES WHEN ACCOUNTING CONTROLS (UNIT PRICING AND UNIT COUNT) ARE APPLIED TO TRANSACTIONS IN RAW MATERIALS, WORK-IN-PROCESS AND FINISHED GOODS.

DISTRIBUTION OF RAW MAT'L AND PRODUCTION ORDERS	TRANSACTIONS CORRECTED	ENDING INVENTORY	NET $ ERROR		ABSOLUTE $ ERROR	
			MEAN	STD DEV'N	MEAN	STD DEV'N
NORMAL (BASE CASE)	NONE	FIN GOODS	20,688	10,153	102,558	10,131
		COMBINED	-38,596	11,969	381,032	21,270
NORMAL	> $3000	FIN GOODS	- 8,585	8,554	73,252	8,664
		COMBINED	-58,784	11,104	315,789	19,078
NORMAL	> $2000	FIN GOODS	-20,261	6,061	38,190	6,099
		COMBINED	-70,090	9,460	196,738	14,493
NORMAL	> $1000	FIN GOODS	- 1,796	1,145	1,723	943
		COMBINED	- 4,093	1,755	36,750	4,191
NORMAL	> $0	FIN GOODS	0	0	0	0
		COMBINED	0	0	0	0

FIGURE D-9

TABULATION OF THE CHANGED MEAN AND STANDARD DEVIATION OF THE DISTRIBUTION OF THE NET DOLLAR ERROR AND ABSOLUTE DOLLAR ERROR FINISHED GOODS AND COMBINED ENDING INVENTORIES WHEN ACCOUNTING ACTIVITY IS CHANGED.

DISTRIBUTION OF RAW MAT'L AND PRODUCTION ORDERS	ACCOUNTING ACTIVITY LEVEL[4]	ENDING INVENTORY	NET $ ERROR MEAN	NET $ ERROR STD DEV'N	ABSOLUTE $ ERROR MEAN	ABSOLUTE $ ERROR STD DEV'N
NORMAL (BASE CASE)	9 MOS.	FIN GOODS	30,688	10,153	102,558	10,131
		COMBINED	-38,596	11,969	381,032	21,270
NORMAL	4.5 MOS.	FIN GOODS	10,008	7,071	51,311	7,043
		COMBINED	-19,478	8,800	190,762	13,903

[4] THE ACCOUNTING ACTIVITY LEVEL WAS NOT DOUBLED TO 18 MONTHS OF ACTIVITY DUE TO THE TIME CONSTRAINTS FOR COMPLETION OF THIS THESIS.

```
*     THIS IS THE PROGRAM FOR THE BASE CASE...FORTRAN G...IBM 360/65

// EXEC FORTCALG,REGION=200K
//FCRT.SYSIN DD *
      COMMON/ONE/RM(4,450),RAW(4),NO(4),J,IEND1(4),ENPUT(4,250)
      DIMENSION  NPUT(4,250),IEND2(4)
      DIMENSION PRAW(4,4),JOB(4,450),EJOB(4,450),WIP(4),NP(4)
      DIMENSION ERM(4,450),ETQMTL(4),TQMTL(4),ETMTL(4),SD(4,450),TMTL(4)
      DIMENSION DLH1(4,450),DLH2(4,450),SDLR(2,4),SDLH(4,2,2)
      DIMENSION EDLH1(4,450),EDLH2(4,450),EEJOB(4,450)
      DIMENSION CK1(4,450),CK2(4,450),QWIP1(4),QWIP2(4)
      DIMENSION SBR(4,2,2),RMRE(4),ERMRE(4),SUMAT1(4),SUMAT2(4)
      DIMENSION QWIP(4),EQWIP(4),TRAN(4),IFGQ(4),IFGQE(4)
      DIMENSION FGI(4),EFGI(4),STCPM(4,2),STCPL(4,2),STCPB(4,2)
      DIMENSION STCP(4,2)
      DIMENSION JOBC(4),ISPLIT(4)
      DIMENSION ERR(4,1500),R(4),IND(4,200 )
      DIMENSION PROB(4,200)
      INTEGER P
      DO 1007 I=1,4
      DO 1007 J=1,200
 1007 IND(I,J)=0
      DO 1009 I=1,4
      DO 1009 J=1,1500
 1009 ERR(I,J)=0.0
      DO 2020 J=1,230
 2020 READ 2021,ENPUT(1,J),ENPUT(2,J),ENPUT(3,J),ENPUT(4,J)
 2021 FORMAT(5X,F5.0,5X,F5.0,5X,F5.0,5X,F5.0)
      DO 2023 J=1,230
 2023 READ 2022, NPUT(1,J), NPUT(2,J), NPUT(3,J), NPUT(4,J)
 2022 FORMAT(5X,I5,5X,I5,5X,I5,5X,I5)
      DO 2000 IM=1,1500
      DO775I=1,4
      NO(I)=0
      JOBC(I)=0
      ETMTL(I)=0.0
      ETQMTL(I)=0.0
      TQMTL(I)=0.0
      TMTL(I)=0.0
      ERMRE(I)=0.0
      RMRE(I)=0.0
      SUMAT2(I)=0.0
      SUMAT1(I)=0.0
```

```
775   NP(I)=0
      DO778J=1,4
      DO778K=1,450
      EDLH1(J,K)=0.0
      EDLH2(J,K)=0.0
      CK1(J,K)=0.0
      CK2(J,K)=0.0
      JOB(J,K)=0
      EJOB(J,K)=0.0
      RM(J,K)=0.0
      ERM(J,K)=0.0
      S D(J,K)=0.0
      EEJOB(J,K)=0.0
      DLH1(J,K)=0.0
778   DLH2(J,K)=0.0
      RAW(1)=40000
      RAW(2)=34000
      RAW(3)=34000
      RAW(4)=32000
      TMTL(1)=108000
      TMTL(2)=133600
      TMTL(3)=45500
      TMTL(4)=52000
      TQMTL(1)=8000
      TQMTL(2)=8000
      TQMTL(3)=7000
      TQMTL(4)=6500
      WIP(1)=33600
      WIP(2)=33000
      WIP(3)=33000
      WIP(4)=28900
      WIPM=0.0
      WIPL=0.0
      WIPB=0.0
      QWIP1(1)=0.0
      QWIP1(2)=0.0
      QWIP1(3)=0.0
      QWIP1(4)=0.0
      QWIP2(1)=0.0
      QWIP2(2)=0.0
      QWIP2(3)=0.0
      QWIP2(4)=0.0
      PRAW(1,2)=6.50
      PRAW(1,4)=13.50
      PRAW(2,2)=8.00
      PRAW(2,4)=16.70
      PRAW(3,2)=13.50
      PRAW(3,4)=6.50
```

```
PRAW(4,2)=16.70
PRAW(4,4)=8.00
STCPL(1,1)=0.5960
STCPL(1,2)=0.4720
STCPL(2,1)=0.8940
STCPL(2,2)=0.7640
STCPL(3,1)=0.4720
STCPL(3,2)=0.5960
STCPL(4,1)=0.7640
STCPL(4,2)=0.8940
SDLH(1,1,1)=.06
SDLH(1,1,2)=.04
SDLH(1,2,1)=.04
SDLH(1,2,2)=.04
SDLH(2,1,1)=.09
SDLH(2,1,2)=.06
SDLH(2,2,1)=.06
SDLH(2,2,2)=.07
SDLH(3,1,1)=.04
SDLH(3,1,2)=.06
SDLH(3,2,1)=.04
SDLH(3,2,2)=.04
SDLH(4,1,1)=.06
SDLH(4,1,2)=.09
SDLH(4,2,1)=.07
SDLH(4,2,2)=.06
SBR(1,1,1)=12.85
SBR(1,1,2)=11.40
SBR(1,2,1)=51.55
SBR(1,2,2)=44.05
SBR(2,1,1)=12.85
SBR(2,1,2)=11.40
SBR(2,2,1)=51.55
SBR(2,2,2)=44.05
SBR(3,1,1)=11.40
SBR(3,1,2)=12.85
 SBR(3,2,1)=44.05
SBR(3,2,2)=51.55
SBR(4,1,1)=11.40
SBR(4,1,2)=12.85
 SBR(4,2,1)=44.05
SBR(4,2,2)=51.55
TRAN(1)=30280
TRAN(2)=30964
TRAN(3)=29777
TRAN(4)=21719
STCP(1,1)=16.9290
STCP(1,2)=9.1900
```

```
STCP(2,1)=21.8435
STCP(2,2)=12.5315
STCP(3,1)=9.1900
STCP(3,2)=16.9290
STCP(4,1)=12.5315
STCP(4,2)=21.8435
STCPM(1,1)=13.5000
STCPM(1,2)=6.5000
STCPM(2,1)=16.7000
STCPM(2,2)=8.000
STCPM(3,1)=6.5000
STCPM(3,2)=13.5000
STCPM(4,1)=8.0000
STCPM(4,2)=16.7000
  STCPB(1,1)=2.8330
  STCPB(1,2)=2.2180
  STCPB(2,1)=4.2495
  STCPB(2,2)=3.7675
  STCPB(3,1)=2.2180
  STCPB(3,2)=2.8330
  STCPB(4,1)=3.7675
STCPB(4,2)=4.2495
IFGQ(1)=4000-30600
IFGQ(2)=4500-31000
IFGQ(3)=6000-29000
IFGQ(4)=5000-21500
IFGQE(1)=4000-30600
IFGQE(2)=4500-31000
IFGQE(3)=6000-29000
IFGQE(4)=5000-21500
FGI(1)=67716.00
FGI(2)=98295.75
FGI(3)=55140.00
FGI(4)=62657.50
EFGI(1)=67716.00
EFGI(2)=98295.75
EFGI(3)=55140.00
EFGI(4)=62657.50
SDLR(1,1)=6.00
SDLR(1,2)=5.60
SDLR(1,4)=6.20
SDLR(2,1)=5.40
SDLR(2,2)=6.20
SDLR(2,4)=5.60
FGMCH=0.0
CWIPCL=0.0
CWIPCB=0.0
WIPLE=0.0
```

```
      WIPBE=0.0
      FTMTL=0.0
      EFTMTL=0.0
      EFG=-1731113.15
      FG=-1731113.15
      KL=1500
      IEND1(1)=201
      IEND1(2)=190
      IEND1(3)=172
      IEND1(4)=177
      IEND2(1)=227
      IEND2(2)=223
      IEND2(3)=220
      IEND2(4)=195
      DO4J=1,4
    4 CALL  INVOIC
      DO7J=1,4
   45 I=NO(J)
      DO7K=1,I
      ERROR=RN(0)
      IF(ERROR.LT..25) GO TO 8
      ERM(J,K)=RM(J,K)
      GO TO 7
    8 MISCOU=RM(J,K)*.10
      ERM(J,K)=RM(J,K)-MISCOU
      MISCOU=0
    7 CONTINUE
      DO17I=1,4
      ETQMTL(I)=TQMTL(I)
      ETMTL(I)=TMTL(I)
      IN=NO(I)
      DO17J=1,IN
      RN5=RN(0)
      IF(RN5.LT..90) GO TO 20
   38 SD(I,J)=PRAW(I,2)
      GO TO 26
   20 SD(I,J)=PRAW(I,4)
      GO TO 26
   26 ETQMTL(I)=ETQMTL(I)+ERM(I,J)
      ETMTL(I)=ETMTL(I)+(ERM(I,J)*SD(I,J))
      TQMTL(I)=TQMTL(I)+RM(I,J)
      TMTL(I)=TMTL(I)+(RM(I,J)*PRAW(I,4))
      ERM(I,J)=ERM(I,J)*SD(I,J)
      RM(I,J)=RM(I,J)*PRAW(I,4)
   17 CONTINUE
      P=0
      DO22I=1,4
      J=1
```

```
      TOT3=0.C
   23 RN7=RN(0)
      MKK=RN7*1000.+1
      MKL=IEND2(I)
      IF(MKK.GT.MKL) GO TO 23
      JCB(I,J)= NPUT(I,MKK)
      DLH1(I,J)=JCB(I,J)*SDLH(I,1,1)
      DLH2(I,J)=JCB(I,J)*SDLH(I,2,1)
      RN9=RN(C)
      IF(RN9.LT..15) GO TO 141
      EJCB(I,J)=JCB(I,J)
      EEJOB(I,J)=EJOB(I,J)
      RN21=RN(0)
      IF(RN21.LT..08) GO TO 200
      P=1
      GC TO 201
  2CC P=2
  201 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)
      CK2(I,J)=P
      RN21=RN(0)
      IF(RN21.LT..08) GO TO 202
      P=1
      GO TO 2C3
  202 P=2
  203 EDLH1(I,J)=EJOB(I,J)*SDLH(I,1,P)
      CK1(I,J)=P
      RN10=RN(0)
      IF(RN10.LT..08) GC TO 142
      EEJOB(I,J)=EJOB(I,J)
      GO TO 25
  142 MISCOU=EJOB(I,J)*.05
      EEJOB(I,J)=EJOB(I,J)+MISCOU
      RN21=RN(0)
      IF(RN21.LT..08) GO TO 206
      P=1
      GC TO 207
  206 P=2
  207 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)
      CK2(I,J)=P
      GO TO 25
  141 MISCOU=JOB(I,J)*.10
      EJCB(I,J)=JOB(I,J)+MISCOU
      EEJOB(I,J)=EJOB(I,J)
      RN21=RN(0)
      IF(RN21.LT..08) GO TO 208
      P=1
      GC TO 209
  208 P=2
```

```
209 EDLH1(I,J)=EJOB(I,J)*SDLH(I,1,P)
    CK1(I,J)=P
    RN21=RN(0)
    IF(RN21.LT..08) GO TO 210
    P=1
    GC TO 211
210 P=2
211 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)
    CK2(I,J)=P
 25 MISCOU=0
    TOT4=TOT3+JOB(I,J)
    IF(TOT4.GE.WIP(I))GO TO 24
    TOT3=TOT4
    J=J+1
    GO TO 23
 24 JOB(I,J)=WIP(I)-TOT3
    EJOB(I,J)=JOB(I,J)
    EEJOB(I,J)=EJOB(I,J)
    DLH1(I,J)=JOB(I,J)*SDLH(I,1,1)
    RN21=RN(0)
    IF(RN21.LT..08) GO TO 212
    P=1
    GC TO 213
212 P=2
213 EDLH1(I,J)=EJOB(I,J)*SDLH(I,1,P)
    CK1(I,J)=P
    DLH2(I,J)=JOB(I,J)*SDLH(I,2,1)
    RN21=RN(0)
    IF(RN21.LT..08) GO TO 214
    P=1
    GC TO 215
214 P=2
215 EDLH2(I,J)=EEJOB(I,J)*SDLH(I,2,P)
    CK2(I,J)=P
    NP(I)=J
 22 CONTINUE
    DO60I=1,4
    NI=NP(I)
    DO60J=1,NI
    P=CK1(I,J)
 73 RN11=RN(0)
    IF(RN11.LT..90) GO TO 71
    RN12=RN(0)
    IF(RN12.LT..50) GO TO 70
    WIPCH=EDLH1(I,J)*SDLR(1,2)
    WIPCHB=EDLH1(I,J)*SBR(I,1,P)
    WIPLE=WIPLE+WIPCH
     WIPBE=WIPBE+WIPCHB
```

```
      CWIPCL=CWIPCL+DLH1(I,J)*SDLR(1,4)
      CWIPCB=CWIPCB+DLH1(I,J)*SBR(I,1,1)
      GC TO 60
   7C WIPCH=EDLH1(I,J)*SDLR(1,1)
      WIPCHB=EDLH1(I,J)*SBR(I,1,P)
      WIPLE=WIPLE+WIPCH
       WIPBE=WIPBE+WIPCHB
      CWIPCL=CWIPCL+DLH1(I,J)*SDLR(1,4)
      CWIPCB=CWIPCB+DLH1(I,J)*SBR(I,1,1)
      GO TO 60
   71 WIPCH=EDLH1(I,J)*SDLR(1,4)
      WIPCHB=EDLH1(I,J)*SBR(I,1,P)
      WIPLE=WIPLE+WIPCH
       WIPBE=WIPBE+WIPCHB
      CWIPCL=CWIPCL+DLH1(I,J)*SDLR(1,4)
      CWIPCB=CWIPCB+DLH1(I,J)*SBR(I,1,1)
   60 CONTINUE
      DO 160I=1,4
      NI=NP(I)
      DC 160 J=1,NI
      P=CK2(I,J)
  173 RN11=RN(0)
      IF(RN11.LT..90) GO TO 171
      RN12=RN(0)
      IF(RN12.LT..50) GO TO 170
      WIPCH=EDLH2(I,J)*SDLR(2,2)
      WIPCHB=EDLH2(I,J)*SBR(I,2,P)
      WIPLE=WIPLE+WIPCH
       WIPBE=WIPBE+WIPCHB
      CWIPCL=CWIPCL+DLH2(I,J)*SDLR(2,4)
      CWIPCB=CWIPCB+DLH2(I,J)*SBR(I,2,1)
      GO TO 160
  170 WIPCH=EDLH2(I,J)*SDLR(2,1)
      WIPCHB=EDLH2(I,J)*SBR(I,2,P)
      WIPLE=WIPLE+WIPCH
       WIPBE=WIPBE+WIPCHB
      CWIPCL=CWIPCL+DLH2(I,J)*SDLR(2,4)
      CWIPCB=CWIPCB+DLH2(I,J)*SBR(I,2,1)
      GC TO 160
  171 WIPCH=EDLH2(I,J)*SDLR(2,4)
      WIPCHB=EDLH2(I,J)*SBR(I,2,P)
      WIPLE=WIPLE+WIPCH
       WIPBE=WIPBE+WIPCHB
      CWIPCL=CWIPCL+DLH2(I,J)*SDLR(2,4)
      CWIPCB=CWIPCB+DLH2(I,J)*SBR(I,2,1)
  160 CONTINUE
      FGMCH=0.0
      DC221 I=1,4
```

```
      NI=NP(I)
      DO221 J=1,NI
      MTUSE=JOB(I,J)
      RMRE(I)=RMRE(I)+MTUSE
      MWIPC=EJOB(I,J)
      MREQ=EJOB(I,J)
      ERMRE(I)=ERMRE(I)+MREQ
      RN22=RN(0)
      IF(RN22.LT..10) GO TO 222
      SD(I,J)=PRAW(I,4)
      GO TO 223
  222 SD(I,J)=PRAW(I,2)
  223 WIPCHM=MWIPC*SD(I,J)
      FGMCH=FGMCH+WIPCHM
      SUMAT1(I)=SUMAT1(I)+(MTUSE*PRAW(I,4))
      SUMAT2(I)=SUMAT2(I)+(MREQ*SD(I,J))
      GO TO 221
  221 CONTINUE
      FTMTL=0.0
      EFTMTL=0.0
      DO233 I=1,4
      TMTL(I)=TMTL(I)-SUMAT1(I)
      TQMTL(I)=TQMTL(I)-RMRE(I)
      ETMTL(I)=ETMTL(I)-SUMAT2(I)
      ETQMTL(I)=ETQMTL(I)-ERMRE(I)
      FTMTL=FTMTL+TMTL(I)
      EFTMTL=EFTMTL+ETMTL(I)
  233 CONTINUE
  234 CONTINUE
      DO 242 I=1,4
      QWIP(I)=QWIP1(I)+QWIP2(I)
      EQWIP(I)=QWIP1(I)+QWIP2(I)
  242 CONTINUE
      DO 260 I=1,4
      NI=NP(I)
      DO 260 J=1,NI
      QWIP(I)=QWIP(I)+JOB(I,J)
      EQWIP(I)=EQWIP(I)+EEJOB(I,J)
  260 CONTINUE
      TRIGER=0.0
      DO 291 I=1,4
      NI=NP(I)
      DO 235 J=1,NI
      JOBC(I)=JOBC(I)+JOB(I,J)
      IF(JOBC(I).GE.TRAN(I)) GO TO 280
      GO TO 281
  280 ISPLIT(I)=JOBC(I)-TRAN(I)
      JOB(I,J)=JOB(I,J)-ISPLIT(I)
```

```
      EJCB(I,J)=EJOB(I,J)-ISPLIT(I)
      EEJOB(I,J)=EEJOB(I,J)-ISPLIT(I)
      TRIGER=1.0
281   IF(EEJOB(I,J)-JOB(I,J).GT.20) GC TC  239
      IFGQ(I)=IFGQ(I)+JOB(I,J)
      IFGQE(I)=IFGQE(I)+EEJOB(I,J)
      QWIP(I)=QWIP(I)-JOB(I,J)
      EQWIP(I)=EQWIP(I)-EEJOB(I,J)
      RN34=RN(0)
      IF(RN34.LT..08) GO TO 236
      P=1
      GC TO  237
236   P=2
237   FGI(I)=FGI(I)+JOB(I,J)*STCP(I,1)
      EFGI(I)=EFGI(I)+EEJOB(I,J)*STCP(I,P)
      SUMAT1(I)=SUMAT1(I)-JOB(I,J)*STCPM(I,1)
      CWIPCL=CWIPCL-JOB(I,J)*STCPL(I,1)
      CWIPCB=CWIPCB-JOB(I,J)*STCPB(I,1)
      FGMCH=FGMCH-EEJOB(I,J)*STCPM(I,P)
      WIPBE=WIPBE-EEJOB(I,J)*STCPB(I,P)
      WIPLE=WIPLE-EEJOB(I,J)*STCPL(I,P)
      GC TO 285
239   EJCB(I,J)=JCB(I,J)
      IFGQ(I)=IFGQ(I)+JOB(I,J)
      IFGQE(I)=IFGQE(I)+ EJOB(I,J)
      QWIP(I)=QWIP(I)-JOB(I,J)
      EQWIP(I)=EQWIP(I)-EEJOB(I,J)
      RN34=RN(0)
      IF(RN34.LT..08) GO TO 243
      P=1
      GC TO 244
243   P=2
244   FGI(I)=FGI(I)+JOB(I,J)*STCP(I,1)
      EFGI(I)=EFGI(I)+EJOB(I,J)*STCP(I,P)
      SUMAT1(I)=SUMAT1(I)-JOB(I,J)*STCPM(I,1)
      CWIPCL=CWIPCL-JOB(I,J)*STCPL(I,1)
      CWIPCB=CWIPCB-JOB(I,J)*STCPB(I,1)
      FGMCH=FGMCH-EEJOB(I,J)*STCPM(I,P)
      WIPBE=WIPBE-EEJOB(I,J)*STCPB(I,P)
      WIPLE=WIPLE-EEJOB(I,J)*STCPL(I,P)
285   IF(TRIGER.EQ.1.0) GO TO 282
      GC TO 235
282   TRIGER=0.0
      GO TO 291
235   CONTINUE
291   CONTINUE
      SUMA=0.0
      EFG=0.0
```

```
      FG=0.0
      DC 264  I=1,4
      FG=FG+FGI(I)
      EFG=EFG+EFGI(I)
      SUMA=SUMA+SUMAT1(I)
  264 CONTINUE
      TIPIE=FGMCH+WIPLE+WIPBE
      TWIPI=SUMA+CWIPCL+CWIPCB
      ERR(1,IM)=EFTMTL-FTMTL
      ERR(2,IM)=TIPIE-TWIPI
      ERR(3,IM)=EFG-FG
      ERR(4,IM)=(EFTMTL+TIPIE+EFG)-(FTMTL+TWIPI+FG)
      WRITE(6,1006) ERR(1,IM),ERR(2,IM),ERR(3,IM),ERR(4,IM)
 1006 FORMAT(' ',10X,F12.2,F12.2,F12.2,F12.2)
 2000 CONTINUE
      I=1
      XACC=0.
      DC 1004  IM=1,KL
      K=(ERR(I,IM)/1000.)+151.
      IF(K.LT.1) K=1
      IF(K.GT.200) K=200
      IND(I,K)=IND(I,K)+1
      XACC=XACC+ERR(I,IM)
      WRITE(6,1013) I,IM,ERR(I,IM),K,KL,IND(I,K)
 1004 CONTINUE
      XBAR1=XACC/1500.
      WRITE(6,2201) XBAR1
 2201 FORMAT(//' XBAR1 = ',F12.2//)
      VACC=0.
      DC 4000  IM=1,KL
      VACC=VACC+((ERR(I,IM))**2)
 4000 CONTINUE
      XVAR1=((VACC)/(1499.))-((XBAR1)**2)
      SIGMA1=SQRT(XVAR1)
      WRITE(6,4001) SIGMA1
 4001 FCRMAT(//' SIGMA1 = ',F12.2)
      I=2
      XACC=0.
      DC 1005  IM=1,KL
      K=(ERR(I,IM)/1000.)+101.
      IF(K.LT.1) K=1
      IF(K.GT.20C) K=200
      IND(I,K)=IND(I,K)+1
      XACC=XACC+ERR(I,IM)
      WRITE(6,1013)I,IM,ERR(I,IM),K,KL,IND(I,K)
 1005 CCNTINUE
      XBAR2=XACC/1500.
      WRITE(6,2202) XBAR2
```

```
2202 FORMAT(//' XBAR2 = ',F12.2//)                                        ***500F
     VACC=0.                                                              ***500G
     DO 5000 IM=1,KL                                                      ***500H
     VACC=VACC+((ERR(I,IM))**2)                                           ***500I
5000 CONTINUE                                                             ***500J
     XVAR2=((VACC)/(1499.))-((XBAR2)**2)                                  ***500K
     SIGMA2=SQRT(XVAR2)                                                   ***500L
     WRITE(6,4002) SIGMA2                                                 ***500M
4002 FORMAT(//' SIGMA2 = ',F12.2)                                         ***500N
     I=3                                                                  ***500O
     XACC=0.                                                              ***500P
     DO 3006 IM=1,KL                                                      ***500Q
     K=(ERR(I,IM)/1000.)+101.                                             ***500R
     IF(K.LT.1) K=1                                                       ***500S
     IF(K.GT.200) K=200                                                   ***500T
     IND(I,K)=IND(I,K)+1                                                  ***500U
     XACC=XACC+ERR(I,IM)                                                  ***500V
     WRITE(6,1013)I,IM,ERR(I,IM),K,KL,IND(I,K)                            ***500W
3006 CONTINUE                                                             ***500X
     XBAR3=XACC/1500.                                                     ***500Y
     WRITE(6,2203) XBAR3                                                  ***500Z
2203 FORMAT(//' XBAR3 = ',F12.2//)                                        ***501A
     VACC=0.                                                              ***501B
     DO 6000 IM=1,KL                                                      ***501C
     VACC=VACC+((ERR(I,IM))**2)                                           ***501D
6000 CONTINUE                                                             ***501E
     XVAR3=((VACC)/(1499.))-((XBAR3)**2)                                  ***501F
     SIGMA3=SQRT(XVAR3)                                                   ***501G
     WRITE(6,4003) SIGMA3                                                 ***501H
4003 FORMAT(//' SIGMA3 = ',F12.2)                                         ***501I
     I=4                                                                  ***501J
     XACC=0.                                                              ***501K
     DO 1008 IM=1,KL                                                      ***501L
     K=(ERR(I,IM)/1000.)+151.                                             ***501M
     IF(K.LT.1) K=1                                                       ***501N
     IF(K.GT.200) K=200                                                   ***501O
     IND(I,K)=IND(I,K)+1                                                  ***501P
     XACC=XACC+ERR(I,IM)                                                  ***501Q
     WRITE(6,1013)I,IM,ERR(I,IM),K,KL,IND(I,K)                            ***501R
1008 CONTINUE                                                             ***501S
     XBAR4=XACC/1500.                                                     ***501T
     WRITE(6,2204) XBAR4                                                  ***501U
2204 FORMAT(//' XBAR4 = ',F12.2//)                                        ***501V
     VACC=0.                                                              ***501W
     DO 7000 IM=1,KL                                                      ***501X
     VACC=VACC+((ERR(I,IM))**2)                                           ***501Y
7000 CONTINUE                                                             ****502
     XVAR4=((VACC)/(1499.))-((XBAR4)**2)                                  ****503
```

```
      SIGMA4=SQRT(XVAR4)
      WRITE(6,4004) SIGMA4
4004  FORMAT(//' SIGMA4 = ',F12.2)
1013  FCRMAT(' ',5X,I5,I5,F12.2,I5,I5,I5)
      DO 1012 I=1,4
      DO 1011 J=1,200
      A=KL
      PROB(I,J)=IND(I,J)/A
1011  WRITE(6,1010) I,J,IND(I,J),PROB(I,J)
1012  CCNTINUE
1010  FCRMAT(' ',10X,I5,I5,I12,F12.5)
      DC 2011 J=1,200
2011  WRITE(7,2008)IND(1,J),IND(2,J),INC(3,J),INC(4,J),J
2008  FORMAT(5X,I5,5X,I5,5X,I5,5X,I5,5X,I5)
      DC 2013 J=1,200
      S=J
      AK14=(S-151.)*1000.
      AK23=(S-101.)*1000.
2013  WRITE(7,2010) PROB(1,J),PROB(2,J),PROB(3,J),PROB(4,J),AK14,AK23
2010  FCRMAT(F7.5,5X,F7.5,5X,F7.5,5X,F7.5,5X,F10.0,2X,F10.0)
      STCP
      END
      SUBROUTINE INVOIC
      CCMMON/CNE/RM(4,450),RAW(4),NO(4),J,IEND1(4),ENPUT(4,250)
      K=1
      TCT1=0.0
   11 RN1=RN(C)
      MK=RN1*1000.+1
      ML=IEND1(J)
      IF(MK.GT.ML) GO TO 11
      RM(J,K)=ENPUT(J,MK)
      TCT2=TOT1+RM(J,K)
      IF(TOT2.GE.RAW(J))GC TO 12
      TCT1=TOT2
      K=K+1
      GC TO 11
   12 RM(J,K)=RAW(J) -TOT1
      NC(J)=K
      RETURN
      ENC
```

```
*     THIS SUBROUTINE IS A PSEUDO-RANDOM NUMBER GENERATOR

//ASM.SYSIN DD *
*
**********************************************************************
*
* PURPOSE
*    RN COMPUTES UNIFORMLY DISTRIBUTED RANDOM VARIATES OVER THE RANGE
*    (0,1).  THE PERIOD FOR THIS GENERATOR IS 2**32 WHICH IS THE LENGTH
*    OF THE FULL SYSTEM/360 WORD GIVING TWICE THE PERIOD OF RANDU.
*
* USAGE
*    RN IS CALLED AS A FORTRAN FUNCTION WITH A DUMMY ARGUMENT OF ZERO
*    IN    X = RN(0)  WHERE X WILL BE ASSIGNED THE NEXT RANDOM DEVIATE.
*
* DESCRIPTION OF PARAMETERS
*    NO FORMAL PARAMETERS
*
* REMARKS
*    THIS ASSEMBLY LANGUAGE ROUTINE GIVES TWICE THE PERIOD OF EXISTING
*    GENERATORS AND IS EXTREMELY FAST.  11.88 MICROSECONDS WITH 4.23
*    MICROSECONDS FOR THE CALLING SEQUENCE.  IT IS TAKEN DIRECTLY FROM
*    SERAPHIN, DOMINIC S., 'A FAST RANDOM NUMBER GENERATOR FOR IBM 360'
*    , COMM. ACM 12,12 (DEC. 1969) 695.
*
* METHOD
*    LEHMER'S MULTIPLICATIVE CONGRUENTIAL SCHEME IS USED.
*    U(K+1) = L*U(K) (MOD P),  X(K+1) = U(K+1)/P  WHERE P = 2**32 AND
*    L = 32781.
*
RN       CSECT
         USING *,15         SET BASE ADDRESS
         L     1,SEED       LOAD U(K)
         M     0,MULT       SEED=SEED*MULT
         ST    1,SEED       STORE U(K+1)
         LD    0,FLOT       FLOAT AND
         AD    0,ZERO       NORMALIZE
         BR    14           RETURN
MULT     DC    F'32781'     2**32
ZERO     DC    D'0'
FLOT     DC    X'46000000'
SEED     DC    F'1'
         END   RN
C                  JOB COMPLETE
//GO.FT06F001 DD SPACE=(CYL,(1,2),RLSE)
//GO.FT07F001 DD SYSOUT=B,SPACE=(CYL,1)
//GO.SYSIN DD *
```

```
*      THIS PROGRAM PLOTS THE DISTRIBUTICN OF ERROR IN ENDING INVENTCRY


// EXEC FORTCLGP,REGION.GO=100K
//FCRT.SYSIN DD *
      DIMENSICN RMAT(202),WIP(202),FINGCS(202),CQMB(202),ERROR(202)
     C,ERROS(202),ERRO2(202)
      DIMENSICN PRETTY(5)
      DIMENSICN LOVELY(8)
      REAL*8 BCDX(4)/'$ ERROR ','IN ENDIN','G INVENT','ORY     '/
      REAL*8 BCDY(3)/'PROBABIL','ITY CF E','RROR    '/
      DO 101 I=1,202
      READ(5,100) RMAT(I),WIP(I),FINGDS(I),COMB(I),ERRCR(I),ERROS(I)
     C,ERRO2(I)
  10C FCRMAT(F7.5,5X,F7.5,5X,F7.5,5X,F7.5,5X,F1C.C,2X,F10.0,1X,F9.0)
  101 CCNTINUE
      XACC=0.0
      DO 1501 I=1,200
      IF(RMAT(I).EQ.0.0) GO TO 1501
      XACC=XACC+(ERRO2(I))*(RMAT(I))
 1501 CONTINUE
      XBAR1=XACC
      VACC=0.C
      DO 1601 I=1,200
      IF(RMAT(I).EQ.0.0) GO TO 1601
      VACC=VACC+((RMAT(I))*(1500.)*((ERRC2(I))**2))
 1601 CCNTINUE
      XVAR1=(VACC/1499.)-((XBAR1)**2)
      SIGMA1=SQRT(XVAR1)
      WRITE(8,102) XBAR1
      WRITE(8,103) SIGMA1
  102 FORMAT('MEAN = $',F10.2)
  103 FCRMAT('STANDARD DEVIATION = $',F10.2)
      REWIND 8
      READ(8,104) PRETTY
      READ(8,105) LOVELY
  104 FCRMAT(4A4,A1)
  105 FCRMAT(7A4,A3)
      CALL PLCTS
      CALL SCALE(ERRO2,202,1,6.,.05,XMIN,DX)
      CALL SCALE(RMAT,202,1,5.,.05,YMIN,DY)
      CALL PLCT(1.,1.,-3)
      DO 10 I=1,4
      CALL AXIS(0.,0.,BCDX,-32,5.,0.,XMIN,DX)
      CALL AXIS(0.,0.,BCDY,24,5.,90.,YMIN,DY)
```

```
      CALL LINE(ERRC2,RMAT,200,1,-6)
      CALL SYMBOL(0.2,5.0,.14,PRETTY,0.0,18)
      CALL SYMBOL(0.2,5.3,.14,LOVELY,0.0,31)
      CALL SYMBOL(1.5,5.6,.14,'* * * * * * *',0.C,13)
      CALL SYMBOL(0.2,6.5,.14,'ACTIVITY LEVEL 18 MONTHS',0.0,24)
      CALL SYMBOL(0.2,6.8,.14,'RAW MATL/PRODN ORDER DISTRIBUTICN NCRMAL'
     C,0.0,40)
      CALL SYMBOL(1.5,7.1,.14,'* * * * * * *',0.C,13)
      CALL SYMBOL(0.2,7.4,.14,'ENDING RAW MATERIAL INVENTORY',0.0,29)
      CALL SYMBOL(0.2,7.7,.14,'PROBABILITY OF DCLLAR ERROR IN',0.0,30)
      CALL SYMBOL(0.2,8.3,.14,'FIGURE C-7A',0.0,11)
      CALL SYMBOL(0.2,10.0,.14,'CARTER/KINLEY',C.C,13)
   1C CONTINUE
      CALL PLOT(-1.0,12.0,-3)
      CALL PLCTE
      STOP
      ENC
```

```
*     THIS SUBROUTINE DOUBLES THE SIZE CF THE AXES TITLES

      SUBROUTINE AXIS (X,Y,BCD,NC,SIZE,THETA,YMIN,DY)                   AXIS0010
      DIMENSION BCD(1)                                                  AXIS0020
      DATA EPS/1.E-6/                                                   AXIS0030
      ZING=1.0                                                          AXIS0040
      IF(NC)1,2,2                                                       AXIS0050
    1 ZING = -1.0                                                       AXIS0060
    2 NAC=IABS(NC)                                                      AXIS0070
      TH=THETA*.0174533                                                 AXIS0080
      N = SIZE+0.50                                                     AXIS0090
      CTH=COS(TH)                                                       AXIS0100
      STH=SIN(TH)                                                       AXIS0110
      TN=N                                                              AXIS0120
      XB=X                                                              AXIS0130
      YB=Y                                                              AXIS0140
      XA = X - 0.1 * ZING * STH                                         AXIS0150
      YA = Y + 0.1 * ZING * CTH                                         AXIS0160
      CALL PLOT (XA,YA,3)                                               AXIS0170
      DO 20 I=1,N                                                       AXIS0180
      CALL PLOT (XB,YB,2)                                               AXIS0190
      XC=XB + CTH                                                       AXIS0200
      YC=YB+STH                                                         AXIS0210
      CALL PLOT (XC,YC,2)                                               AXIS0220
      XA=XA+CTH                                                         AXIS0230
      YA=YA + STH                                                       AXIS0240
      CALL PLOT(XA,YA,2)                                                AXIS0250
      XB=XC                                                             AXIS0260
   20 YB=YC                                                             AXIS0270
      IF(DY)22,31,22                                                    AXIS0280
   22 CHAR=ABS(YMIN)                                                    AXIS0290
      ABSV=ABS(YMIN+DY)                                                 AXIS0300
      IF(ABSV - CHAR)5,6,6                                              AXIS0310
    5 ABSV = CHAR                                                       AXIS0320
    6 POW=0.0                                                           AXIS0330
      CALL ANN(ABSV,BBSV,KPOW)                                          AXIS0340
      POW=KPOW                                                          AXIS0350
   93 ADY = DY * 10.0 ** (-POW)                                         AXIS0360
      ABSV = YMIN * 10.0**(-POW)       +TN * ADY                        AXIS0370
      XA = XB - (.20 * ZING - .05) *STH - .0857 * CTH                   AXIS0380
      YA=YB +(.20 * ZING - .05) * CTH -.0857 * STH                      AXIS0390
      N=N+1                                                             AXIS0400
      DO 30 I=1,N                                                       AXIS0410
      IF (ABS(ABSV)-EPS) 101,101,100                                    AXIS0420
```

```
 1CC CALL NUMBER(XA,YA,0.14,ABSV,THETA,2)                          AXISC43
 101 ABSV = ABSV - ADY                                             AXIS0440
     XA = XA - CTH                                                 AXIS0450
  3C YA = YA - STH                                                 AXIS0460
  31 TNC = NAC + 7                                                 AXIS0470
     XA=X+(SIZE /2.0-.06 *TNC)*CTH - (-.00 + ZING*.36)* STH        AXIS0480
     YA=Y+(SIZE /2.0-.06 *TNC)*STH + (-.14 + ZING*.36)* CTH        AXIS0490
     CALL SYMBOL(XA,YA,0.14,BCD,THETA,NAC)                         AXIS0500
     XA=XA+((TNC-6.0) * 0.12)*CTH                                  AXIS0510
     YA=YA+((TNC -6.0) * 0.12)*STH                                 AXIS0520
 802 IF(DY)801,50,801                                              AXIS0530
 801 IF(POW) 35,50,35                                              AXIS0540
  35 CALL SYMBOL(XA,YA,0.14,7H(X10   ),THETA,7)                    AXIS0550
     XA = XA + .48 * CTH -.07 * STH                                AXIS0560
     YA = YA + .48 * STH +.07 * CTH                                AXIS0570
     IF(POW) 40,50,40                                              AXIS0580
  4C CALL NUMBER (XA,YA,0.14,POW,THETA,-1)
  50 RETURN                                                        AXIS0600
     END                                                           AXIS0610
//GC.FTC8F001 DD UNIT=SYSDA,SPACE=(TRK,1)
//GC.SYSIN DD *
```

LIST OF REFERENCES

1. Burns, David C., Audit Evidence Evaluation Using Computer Simulation with Special Emphasis on Ascertaining the Reliability of Accounting Data (Indiana State University Graduate School of Business, 1971), Unpublished Doctoral Dissertation.

2. Committee on Auditing Procedure, Statement of Auditing Standards #1, American Institute of Certified Public Accountants, Inc., 1973.

3. Naylor, Thomas H., Balintfy, Joseph J., Burdick, Donald S., and Chu, Kong, Computer Simulation Techniques, New York: John Wiley and Sons, Inc., 1968.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 0212 Naval Postgraduate School Monterey, California 93940	2
3.	Asst Professor David C. Burns, Code 55 Bu Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	5
4.	Asst Professor Ronald S. Barden, Code 55 Ba Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1
5.	CDR F. H. M. Kinley 1124 S. 18th Street Arlington, Virginia	1
6.	LCDR J. O. Carter USS Piedmont (AD-17) FPO San Francisco, California 96601	1
7.	Library, Code 55 Department of Operations Research and Administrative Sciences Naval Postgraduate School Monterey, California 93940	1

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) RELIABILITY IN COMPLEX INVENTORY ACCOUNTING SYSTEMS: A SENSITIVITY ANALYSIS		5. TYPE OF REPORT & PERIOD COVERED Master's Thesis; September, 1973
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Frederic Henry Michael Kinley James O'Neill Carter		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Postgraduate School Monterey, California 93940		12. REPORT DATE September 1973
		13. NUMBER OF PAGES 205
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Postgraduate School Monterey, California 93940		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Reliability
Inventory Accounting Systems
Computer Simulation
Sensitivity Analysis

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis investigates the sensitivity of the reliability of the data generated by a complex inventory accounting system to changes in various internal and external factors effecting the subject accounting system. The subject system is represented by a computer simulation model of the inventory accounting subsystem of a hypothetical firm. The model, which is described

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
(Page 1) S/N 0102-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. Abstract.

in detail, was designed by David C. Burns; and was the subject of his doctoral dissertation. Sensitivity tests were performed on the computer model to investigate its responsiveness to various changes in both external and internal factors. The results of these sensitivity tests are analyzed with respect to their impact on the reliability of the data which makes up ending inventory account balances generated by the model. A dual quantitative method of measuring account balance reliability is also proposed and evaluated. A recommendation is made that the simulation technique be field tested for possible later status as a generally accepted auditing procedure.

Thesis 146934
K459 Kinley
c.1 Reliability in complex inventory accounting systems: a sensitivity analysis.